PUBLIC WORKS.

CITY COUNTY STATE

A COMBINATION OF

"MUNICIPAL JOURNAL & PUBLIC WORKS" and "CONTRACTING"

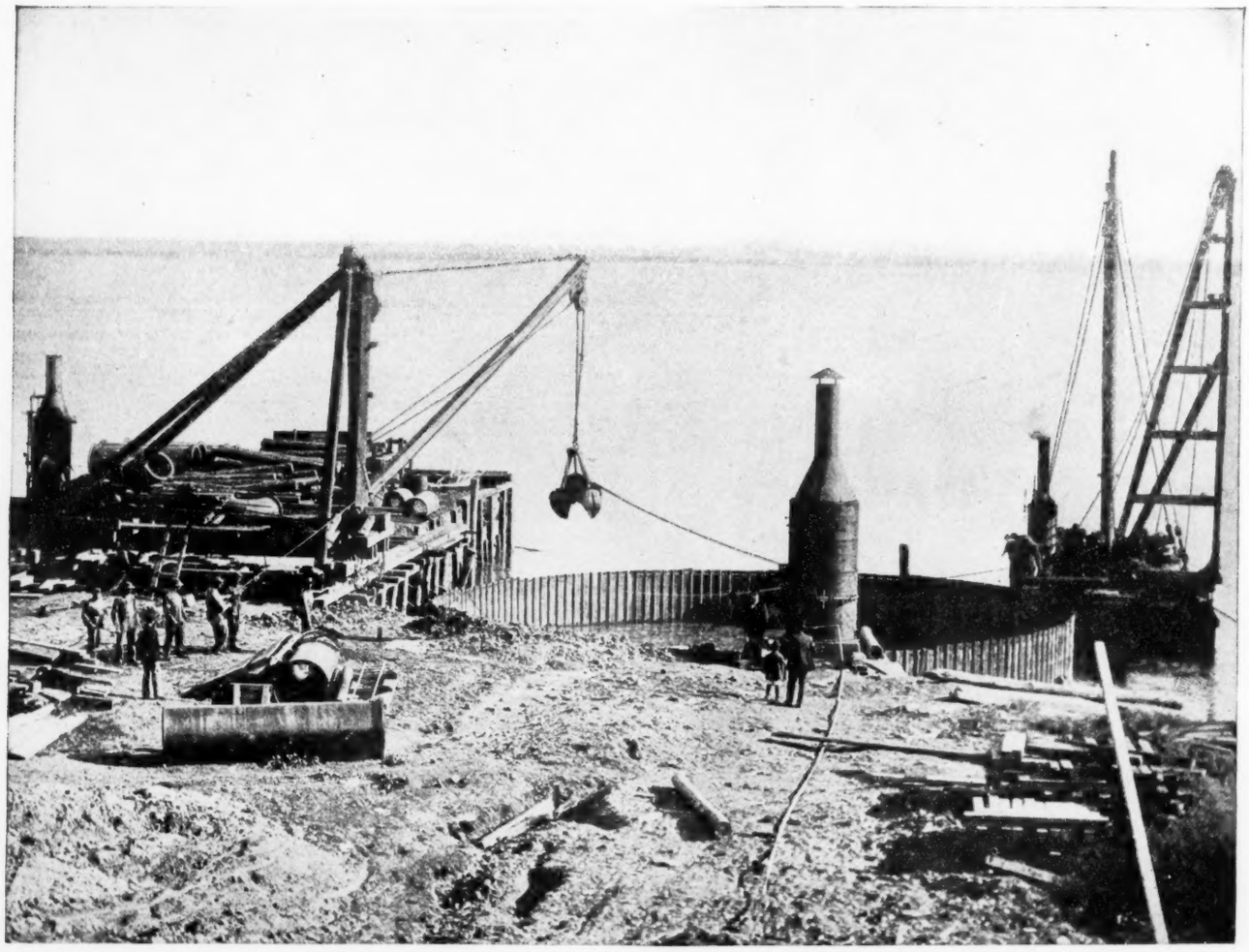
THE TALLEST CHIMNEY IN THE WORLD, AT ANACONDA, MONTANA—86 FEET IN DIAMETER AND 585 FEET HIGH. THE METHOD OF CONSTRUCTING WILL BE DESCRIBED NEXT WEEK.

In this issue:

Volume 48, No. 8 NEW YORK, MARCH 6, 1920 Weekly—$3.00 a Year

PUBLIC WORKS

Hayward Buckets



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PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL AND PUBLIC WORKS" and "CONTRACTING"

Vol. 48 NEW YORK, MARCH 6, 1920 No. 8

Building the Hartford Filter

Methods and plant used by the contractor in building a slow sand filter covering five acres and roofed over. Special trolley line for delivering materials to site; concrete distributed entirely by spouting; collapsible roof forms used eight times.

The water works of Hartford, Conn., are among the oldest in the country, and the extensions and improvements made during the past three or four years have been among the most extensive and important of those made by the larger cities of the country during recent years. Prior to 1855 there had been a small water works system owned by private parties, but in 1855 a municipal plant started operation under a Board or Water Commissioners. This system pumped water from the Connecticut river, which source was used until a gravity supply was put in operation in 1867 by storing water from Trout brook. The gravity supply was enlarged from time to time, but by far the greatest increase was that put into use about two and one-half years ago, with the completion of the Nepaug reservoir. This reservoir has an impounding capacity of nine and one-half billion gallons and a water-shed of thirty-two square miles—more than twice the area of the water-shed formerly drawn upon.

This reservoir, completed in 1917, solved for many years to come the problem of quantity of supply. The quality, however, could not be considered entirely satisfactory, since all of the water came from surface flow and streams, and the plans which have been under development for several years past included the filtering of the entire supply. The plant for effecting this is well along toward completion. It consists of four acres of slow sand

ARRANGEMENT OF FORMS, DELIVERY OF CONCRETE THROUGH SUSPENDED CHUTE AND DISTRIBUTION BY CARTS FOR FLOOR OF FILTER SECTION

filters designed to operate at the rate of five million gallons per acre. The twenty million gallons so provided for are abundantly ample for the present, the average daily consumption being about twelve million gallons; but to provide for the future, land was secured and arrangements made for constructing another filter of equal capacity adjacent to this one. The estimated cost of the filter now under construction is about $600,000.

THE FILTER STRUCTURE.

This structure is built of reinforced concrete, with a a groined roof, groined floor, vertical columns and side walls. The exterior dimensions are about 572 feet by 350 feet by 14 feet high. The columns are 13 feet apart on centers, longitudinally and transversely, and are 20 inches square, without reinforcement. The roof has a minimum thickness of about 6 inches and is reinforced only adjacent to the outer wall.

The outer wall has a thickness of 2 feet, 9 inches at the base, tapering to 2 feet at the top, with vertical inside face, and is reinforced with vertical twisted bars.

The filter is divided into eight duplicate rectangular units in two rows of four each, each unit being enclosed by division walls common to both. Each unit is about 143 feet by 169 feet, being divided into eleven panels one way and thirteen the other way.

The filter is constructed on an approximately level site, which was excavated from six to eight feet to sub-grade, principally on solid rock.

The principal quantities involved are:

32,380 yds. of concrete
300,000 lbs. reinforcement steel
42,600 yds. earth excavation
8,800 yds. rock excavation
17,000 yds. rolled embankment
34,500 yds. back fill
32,000 bbls. Portland cement.

The contract price for the reservoir was about $600,000 with

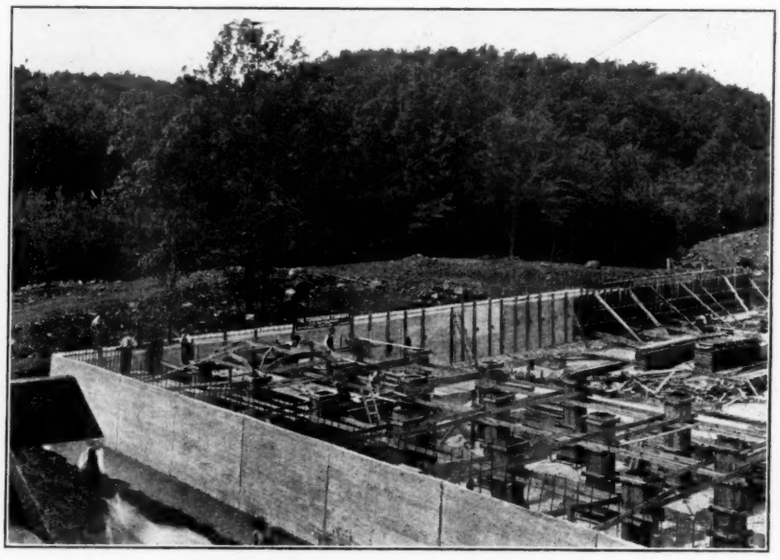
Earth excavation at	$ 1.00	
Rock excavation at	5.00	
Class "A" concrete	14.00	cu. yd.
" "B" "	7.50	" "
" "C" rein. concrete	13.50	" "
" "D" concrete not requiring forms	4.00	" "
Rolled embankment	1.10	" "
General fill	.80	" "

As it was realized in the beginning that considerable difficulty would be involved in delivering plant and materials, the contractor built about 3,000 feet of standard-gauge trolley track from West Hartford to the site, where the end nearest the filter was carried on 400 linear feet of four-post timber trestle, 18 feet high.

On this track there were delivered during the progress of the work all materials and the contractor's plant and equipment. The road was built in about six days by the contractor's forces.

A Thew and an Erie steam shovel, with 7/8 yard buckets, were installed for the excavation of the loamy earth and the rock, after the latter had been shattered. They delivered the excavated material to two-horse bottom-dump wagons, by which it was transported a maximum distance of 200 feet and deposited in bunkers and on the rolled embankment, the former being later used to make a large percentage of the back-fill, the remainder of which will be furnished from an adjacent borrow pit.

A battery of three boilers and two air compressors was installed in a central plant, to furnish power for about six Ingersoll-Sargent tripod drills used in the excavation work. The same plant distributed steam around the site for two derrick hoists, also to operate concrete mixers and supply pumps and operate the saw milling plant.

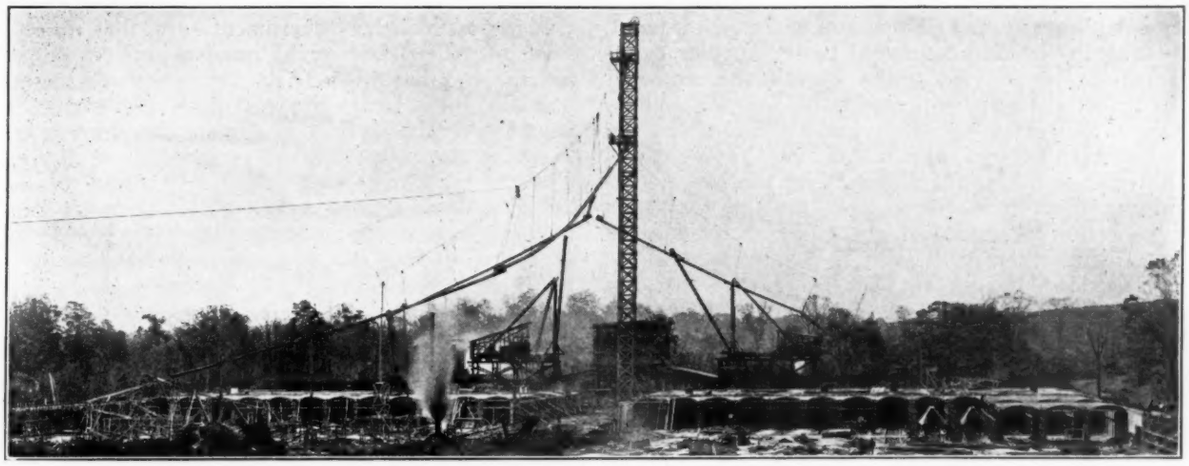


FORMS FOR SIDE WALLS AND COLUMNS

CONCRETING EQUIPMENT.

Sand and gravel purchased from the producers were delivered over the trolley line and unloaded from dump cars on the trestle to storage piles on the ground below. A stiff-leg derrick and clam-shell bucket delivered the aggregate from the storage piles to bins, which had capacities of 500 yards of gravel and 300 yards of sand. Each bin had two sliding gates in the hopper bottom at an elevation of about 20 feet above the surface of the ground, thus enabling them to deliver directly to the charging hoppers of two one-yard Lakewood concrete mixers installed on a platform about 8 feet above the surface of the ground. Cement, also delivered over the trolley road, was stored in a shed of 2,500 barrel capacity adjacent to the mixers in the bins, and was placed by conveyor in the charging hoppers.

The two mixers discharged through a common spout to the hoisting bucket under the foot of a wooden tower 176 feet in height that had its foundation sills in the bottom of a pit about 5 feet



CONCRETE MIXING, HOISTING AND SPOUTING PLANT AND ELEVATED DERRICKS.

deep. The tower was about 8 feet square and was assembled complete in horizontal position on the ground and revolved into position with two derricks, the cables being attached to the tower with a bridle. The tower is guyed at the top and center points with four guys at each point, anchored to trees and deadmen. The tower was located close to the filter on the center line, and supports a main cable in the plane of the center line, running the full length of the filter, with transverse cables supported by it over the center of each unit. The ends of these cables are anchored to trees, or to deadmen consisting of inclined stakes. From the main and transverse cables, ½-inch manila tackles are suspended about 16 feet apart to carry the Lakewood chutes through which the concrete is spouted to required position.

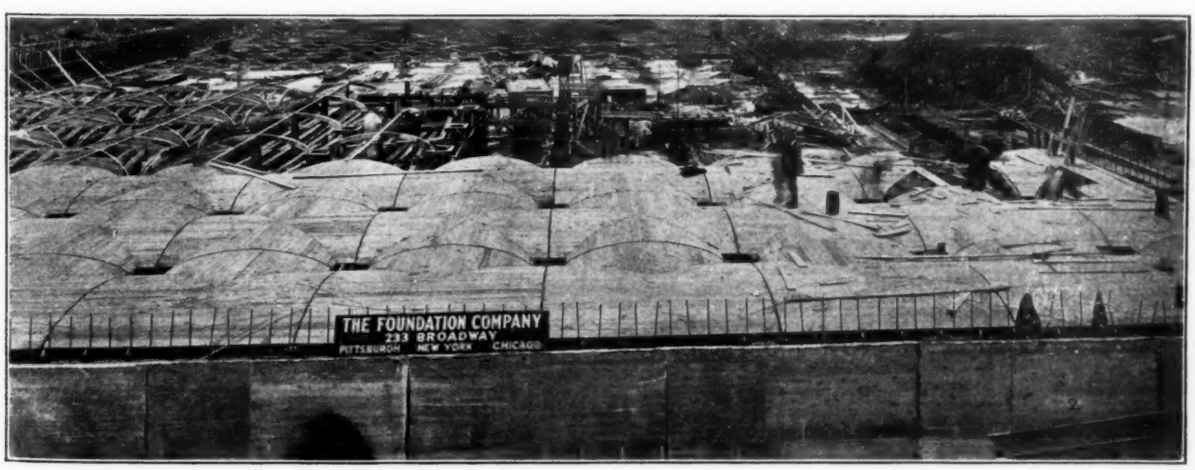
The first four units were supplied from a receiving hopper located near the mid-height of the tower and the last four were supplied from the hopper at the top of the tower. The concrete mixers were of the Lakewood type.

CONSTRUCTION OF FILTERS.

The invert was designed of the shallow, reverse groined type, in order to provide drainage and location for the half-pipe collectors. Each panel, 13 feet square, sloped from the summit, where the column is seated, to the center point or invert line.

The invert was made in two operations, the first of which consisted of the construction of diamond-shaped areas, having their transverse diameter at the low point, with the apexes of the opposite diameter at the bases of the columns. These sections were constructed simultaneously in longitudinal rows across the full width of each filter unit, several adjacent rows being built simultaneously. They were made with vertical wooden side forms having inclined upper edges to which the surface of the concrete was screeded with wooden straight edges and afterwards troweled. These preliminary sections inclosed between them corresponding open diamond-shape areas, which were later filled with concrete screeded with a recess joint, which was afterwards asphalted. The spaces between the first sections of the invert were filled with concrete that was screeded with straight edges worked on the old concrete. At the corners of each finished panel, horizontal recesses were left to receive the vertical columns, which were built in ordinary knock-down wooden forms.

The roof forms were each portions of a cylindrical arch, 13 feet long and 13 feet span, intersected



SUPPORTS FOR CONCRETING GROINED ROOF ARCHES. IN BACKGROUND LAGGING STRIPPED TO EXPOSE RIBS AND SHORES.

by a duplicate arch at right angles at the center point, making the lagging consist of two triangular cylindrical surfaces joined at the apex in the center of the panel. These were supported on the column forms, and after the latter had been removed the horizontal ties, or lower chords, were removed and the ribs of the forms collapsed at the hinge, permitting them to be disengaged and lowered to a support on the tower of a car, which transferred them to another panel, where they were adjusted for service. Each form was made with two ribs intersecting at an angle of 45 degrees at the center. Enough forms were built for one full unit at the contractor's shop, which was equipped with a planer, rip-saw, cut-off saw, cutting machine, boring machine, and a band-saw. About thirty form builders were employed in making, shifting and repairing the forms. About 40,000 feet board measure was required for the forms and shoring, 10,000 pounds of iron work, and 350 gallons of crude oil, with which the form was painted each time it was used. The forms were used eight times. The concrete delivered from the tower to the main-line chutes and the main transverse chutes, was distributed from the latter through line gates and 16 or 32 feet lengths of movable chutes, thus eliminating all wheeling or hand labor of distribution. The upper surface of the roof was screeded to the cylindrical soffits of the groined arches.

Especial attention was paid by the contractor to the design and construction of the forms, which are believed to be cheaper, lighter and more durable than often found in such work.

The work was executed by an average force of 100 to 150 men, who are also constructing the aerator, the regulator houses and the laboratory and pipe lines.

Owing to the scarcity and poor quality of labor, the contractor established a camp, with houses, commissary storehouse and the usual adjuncts for sanitary and social requirements, and secured forces largely from the vicinity of New York, after which the turn-over was considerably decreased.

The contractor for the work is the Foundation Company, of New York City. The filters were designed and are being built under the direction of Caleb Mills Saville, chief engineer and general manager of the Board of Water Commissioners.

Encouraging Timber Estimate

The National Lumber Manufacturers Association says that "of the two trillion eight hundred billion feet of standing timber now in the United States, according to the best available figures, nearly one-half is in the Pacific Coast forests, somewhat over one-fourth in the southern forests, one-ninth in the central forests, one-ninth in the Rocky Mountain region and about one-tenth in the northern forests.

Washington and Louisiana are the greatest lumber-producing states of the union, the former producing four billion and a half board feet of lumber in 1916, and the latter four billion two hundred million. Missippi and Oregon follow with 2,700,000,000 and 2,200,000,000 feet, respectively, and Oregon, Texas, Arkansas and North Carolina produced each about two billion feet in 1916.

It is possible, the Government says, that its estimate of two trillion eight hundred billion feet is too low and that this may not represent half the actual amount. If the figures given are correct it would take sixty years to deplete our forests entirely: if the actual amount is twice these figures, it would take over one hundred years and this on the basis of no new growth at all. Very good commercial trees may be grown in sixty years so that the timber supply in this country is practically inexhaustible with moderate care, reasonable protection, especially as regards fire and insect ravage, and moderate re-forestation."

9,000-Ton Concrete Pump Well Constructed Floating

The 96x45-foot concrete pump well 60 feet high for the Pearl Harbor Dry Dock at Honolulu was built by the San Francsco Bridge Co., floated to place, and sunk to final position on a deeply submerged foundation by the use of a floating dry dock in which the construction was commenced, and a detachable wooden cofferdam that permitted the remainder of the concrete to be placed after the lower portion, temporarily serving as the bottom of the cofferdam, was removed from the dry dock and remained floating.

The pump well is a rectangular reinforced concrete box with solid floor and open top and is divided into five large and five smaller chambers by one longitudinal, and four transverse interior concrete walls integral with the exterior walls and floor.

The floor, 3 feet thick, and all of the walls up to a height of 18-feet were concreted in forms installed in a 3,500-ton wooden floating dry dock that had previously been used in the construction of the Pearl Harbor concrete grading dock. Brackets and extensions to the exterior walls, 17 feet above the bottom provided support for bottom sills on which, while the lower portion of the pontoon was in the dry dock, there was erected a sectional detachable wooden cofferdam with interior dimensions of 48 feet 8 inches x 100 feet 2 inches and a height of 40 feet. The cofferdam was braced with six courses of longitudinal and transverse horizontal struts dividing it into 21 interior panels clear of the inner faces of the outer walls, and 24 smaller exterior panels formed by the extension of the braces through the permanent outer walls to the sheeting.

The longitudinal and transverse struts cleared each other with their adjacent horizontal surfaces in the same planes and were supported at intersections by vertical struts. The framework was trussed by X-braces in panels or groups of panels between the vertical struts and between the horizontal members.

Stockton, San Joaquin County, Cal., is considering plans for Harbor Improvement of an estimated cost of about $4,000,000 that have been prepared by S. A. Jubb. The items include channels for light and deep darft ships, municipal railroad yards, a belt line railroad and the excavation and removal of the Weber peninsula.

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A. PRESCOTT FOLWELL, *Editor*
FRANK W. SKINNER, *Associate Editor*

Co-ordinating Big Construction With Finance

The project of a great municipal water supply and power development for the city of San Francisco ranks among the most difficult, extensive and costly of its kind, and now after considerable delay, due to war conditions, is being prosecuted with vigor and able executive, engineering and financial direction that assure successful completion betimes of an almost unprecedented undertaking that has been in progress for nearly twenty years, and was just commencing its physical development at the beginning of the world war.

As outlined on page 165 this great aqueduct and appurtenances for the ultimate supply of more than four hundred million gallons of water daily, plus the development of 250,000 horse-power of electrical energy at a cost of about forty-five million dollars, is directly comparable with only two other finished works and is exceeded in cost by only one.

The collection and storage of this great volume of water at an elevation 3,500 feet above the city and its delivery by a conduit 68 miles long was made possible by an act of Congress giving the city 420,000 acres of public land, and by the municipal authorization of 45,000 4½ per cent $1,000 bonds, maturing in successive years from 1922 to 1964, which are being sold as necessary to provide construction funds.

A masterly investigation of the engineering conditions and requirements determined the advantages and ultimate economy of expending several million dollars in auxiliary construction to expedite and cheapen the necessary work on permanent construction, and to this end 68 miles of standard gage mountain railroad was built for the transportation of materials and equipment needed on the work; a large storage dam and ten miles of natural and artificial conduit were built to provide water for a 4,500 horse-power hydro-electric plant to operate construction machinery for the permanent works, timber land was secured, a saw-mill put in operation and a force of about 500 men organized to operate them. This has provided not only for the construction of necessities, but for commercial business that has already resulted in a revenue from the railroad and an income of more than $67,000 from the power plant during the year 1918-19.

The permanent work has been classified in ten great divisions, three of which, the construction power plant, the main dam, and the twenty-mile mountain tunnel are already under construction with a total present force of about 800 men. The manner in which this work is being conducted so as to utilize natural forces, develop the greatest potential value from the system and distribute the financial burden in the easiest and most advantageous manner, is highly creditable to City Engineer M. M. O'Shaughnessy and the other officials and associates responsibly associated with it. The largest auxiliary item is the railroad, a financial, construction, and economic success described in the first of a series commenced in this issue.

Return of Railroads Good For Construction

The return, March 1, of our $20,000,000,000 railroad system to private control is of the utmost potential advantage for national prosperity, construction interests and activities, the reduction of the high cost of living, and restoration of the value of the dollar. The extravagant and arbitrary management, drastic measures enforced, great depreciation of property permitted, discrimination against specific interests, and, above all, the low morale developed under government management, have affected the greatest, most intricate, and one time most marvelously efficient system in the world in a way that has been so patent that the whole nation, except the railroad labor profiteers, is strong for a return to the old condition.

This will take time and, it is authoritatively estimated in the Railway Age, the expenditure of about $6,000,000,000 within the next three years to make good as much as possible, the deterioration now existing. This will of course involve increased freight rates that should be accompanied by a scaling down of wages and an enormous increase of efficiency in the personnel, features which no reasonable critic can object to in view of the fact that the operating expenses of the roads have increased 102 per cent since 1914, while freight rates have been increased only 34.4 per cent, and more men do less and poorer work in more man-hours at higher pay.

The combined necessity and opportunity for earning profits will be a great factor in the increased and improved service to shippers and it will be found that construction materials and equipment will not be unnecessarily discriminated against so that engineering operations of all sorts can go on with much greater speed, economy and certainty.

The expenditure of $6,000,000,000 in three years means the execution of a vast amount of long delayed reconstruction and new construction, involving great quantities of all kinds of heavy construction work, equipment, and materials—a prospect that is highly satisfactory for big and little contractors and at the same time constantly facilitates the construction and operation of every other kind of public work. The high cost of our experiment in government controlled railroads will be partly offset by the great impetus it has given to the development of motor truck transportation and the economic lesson to the public.

Safe Pile Loads

Hardly any factor of design is so uncertain as the safe bearing capacity of foundation piles that is influenced by many conditions, most of them unknown in advance, difficult to determine and often subject to change without apparent cause or indication. The necessity of absolutely reliable foundations for all important structures is increased by the fact that the foundations are generally the most inaccessible portions of the structure, and are difficult to test or inspect. Any serious failure in them is likely to endanger all the rest of the structure even to the point of destruction or of repairs that may easily amount to many times the original cost of the foundation and may also involve new foundations or modifications of old ones that are exceedingly difficult, uncertain and costly to make.

The only safe practice is therefore a highly conservative one, using a large factor of safety, or as the late Theodore Cooper aptly termed it, "factor of ignorance."

Excepting where comparatively short piles are satisfactorily seated on solid rock or very hard stratum and the piles act as simple columns there are few cases where the bearing strength can be at all accurately determined, even at first, or where it may not be subject to serious change, often due to unsuspected changes of conditions. The lowering of ground water level by natural or artificial causes; adjacent building or excavating operations; impact; vibration; deterioration of the pile material, and various other causes may operate to greatly reduce it, so that a large margin of safety should always be allowed whenever there is any uncertainty as to conditions, and excessive loads should never be permitted.

Preliminary explorations by test holes and pits should be made where conditions permit, and where large numbers of piles are used, their length, size, and number, should be largely determined by the results of test piles driven and loaded in advance, and accurate records made of their settlements and penetration under impact and static loads.

For 12-inch piles, not less than 3 feet apart, driven to a penetration of 15 feet or more in ordinarily firm soil, the ordinary maximum load of 10 tons should not be carelessly exceeded, and in some cases, should not be allowed.

No element of the piles load capacity is more uncertain than the resistance to settlement due to skin friction which varies many hundred per cent with the character of the soil and other factors. In very soft mud where a long pile will often penetrate 20 or 30 feet under its own weight alone, skin friction is rapidly developed after a pile comes to rest and in the course of a few hours may often be so great as to resist displacement by heavy impact that would previously have caused many inches penetration. This fact, the difficulty of sinking undermined caissons that are held up only by skin friction, the difficulty of pulling piles, and other reasons have produced in many quarters an exaggerated estimate of the value of skin friction that may be properly used for proportioning the pile load. Some practical features of the skin friction actually existing on piles in service are given in the valuable extract, page 173, from a paper based on many years of experience of an eminent construction engineer with earth pressures and resistancies that demonstrates the necessity for very conservative assumptions.

Increase Efficiency, Energy and Economy

We can no longer be content with easy going efficiency. Every kind of useful efficiency must be doubled, trebled, and multiplied. Labor, art, science, commerce, education and even politics must greatly increase the time and intensity of their efforts. No 6-hour, 8-hour, or even 10-hour day's work suffices. We must work as long and as hard as considerations of health, strength, and public welfare permit, multiplying and improving our production and making up this tremendous deficit. Even so, with the wonderful improvements and conveniences afforded by science and machinery our comforts and luxuries, our privileges and enjoyments will be infinitely greater and our hardships incomparably less than those of our pioneer forbears of only three or four generations ago.

In these things contractors play a leading part. Wise economy and resistless energy will build great works that are otherwise impossible and open tremendous fields for production by other classes. They will make work where work is now absent or hesitating. They will make profits where old methods and habits show only loss and they will bring strength and prosperity to every kind of necessary construction in all parts of this country, if every man will simply concentrate the utmost energy and determination to increase construction work of every useful kind, to make opportunities for it, and fill them, to economize wisely in time, in labor, in materials, and in every other item to the extent of increasing efficiency and eliminating all waste and extravagance. The first and biggest consideration is to have no lost motion, no lost time, no lost labor, no wasted materials, no lack of co-ordination, no lack of preparation, and no lack of skilled control. It means careful planning, the selection and education of labor, the survival of the fittest, reward of success, punishment for failure, ingenuity and originality in design and in the selection of material. Above all, it means economical and therefore large scale work, in every case accomplished by power and by the highest class of machinery that will work day and night incessantly without Sunday, holiday, or strike interruption. This will pay a large return on the investment and conserve human intelligence and adaptability for special operations.

Inevitable Results

Philadelphia's wage scale increased 120 per cent in 1918 over 1917, while the value of production in all classes of industry increased 30 per cent, according to M. Hoke Gottschall, of the State Department of Internal Affairs.

The value of Philadelphia's products for 1918 is placed at $1,913,852,400, as compared to $1,559,148,200 in 1917. This shows a reduction of about 6 per cent in the actual volume of production to correspond with the enormous increase of wages.

Hetch Hetchy Water Supply—1

154-mile aqueduct and auxiliaries for ultimate delivery of 400,000,000 gallons daily to San Francisco at estimated cost of $45,000,000. Preliminary work, more than $2,000,000. Construction of railroad 68 miles long, requiring 1,000,000 yards of excavation and having four per cent grades and 30 degree curves, built by the city of San Francisco.

In 1914 preliminary work was commenced on the construction of a water supply system for the city of San Francisco that it is estimated will be completed in 1923 at a cost of about $45,000,000. Notwithstanding the difficulties, increased expense, and interruptions caused by the war, and the uncertain conditions of the labor and material markets the work has been prosecuted vigorously and much important construction has already been accomplished at a cost of about $8,000,000 expended up to Nov. 1st (including about $2,000,000 for lands, water rights and early investigations). Most of the preliminary and auxiliary work has been completed, many of the important operations and principal constructions for the aqueduct and main dam are now in progress.

The present time is therefore suitable for a review of the general features of the completed work and descriptions of the methods that have been adopted and the plant that has been installed on it, and for the current work, essential features of which will be described in the present and succeeding articles timed to present a connected outline of a large part of the principal construction at the most advantageous period.

SIZE AND IMPORTANCE.

The Hetch Hetchy system, one of the greatest and most difficult of its kind in the world, is closely comparable with only two others, both of them very recently completed at enormous costs.

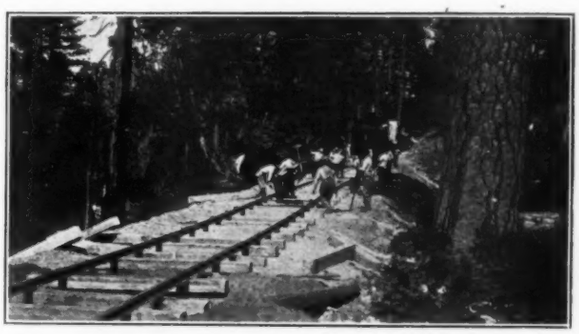
The Los Angeles aqueduct, 223 miles long, includes about 63 miles of canals, 98 miles of covered conduits, 43 miles of tunnels, 12 miles of steel and concrete syphons, and has cost about $27,000,000. The aqueduct is designed to afford a supply of 260,000,000 gallons daily, for an ultimate development of 49,000 h.p. and was built and put in service in about six years.

The principal elements of the Catskill Water Supply for the City of New York are the 128,000,000,000 gallon Ashokan Reservoir that delivers 250,000,000 gallons daily through an aqueduct 92 miles long including 55 miles of cut and cover concrete structure, 31 miles of tunnels and 6 miles of steel pipes. Inside the city limits are, in addition 18 miles of pressure tunnel and 14 miles of pipe. The construction was substantially completed in about 8½ years at a total cost of about $136,000,000.

Both the Los Angeles and the New York Supplies have been executed with the latest development of engineering and construction methods, operations and plant. A third great system, the Metropolitan water supply system for Boston and neighboring cities, has been completed and in successful operation for a number of years but the developments and methods involved in its construction were not so far advanced or so closely parallel, as those of the other systems are with that of the San Francisco system.

THE HETCH HETCHY SYSTEM.

The investigations for the Hetch Hetchy system began nearly 20 years ago and some of the features eventually adopted were presented in the Grunsky Report of 1902 for an ultimate supply, by combined pumping and gravity systems, of 160,000,000 gallons a day through an aqueduct 182 miles long. Various modifications were subsequently proposed that ultimately resulted in the adoption of the present plan providing for an ultimate supply of 400,000,000 gallons a day in the Tuolumne water shed and its delivery to the city limits through an aqueduct 154 miles long.



TAMPING BALLAST IN CONSTRUCTION OF HETCH-HETCHY RAILROAD.

It also provides for the ultimate development, on the line of the aqueduct, of about 200,000 hydro-electric h.p. The water will be delivered entirely by gravity. The tunnels of the aqueduct will be designed for their ultimate capacity of 400,000,000 gallons a day while the pipe siphons across the broad valleys will have an initial capacity of 60,000,000 gallons a day, provisions that contemplate enlargement and additions as required and a large ultimate economy by saving interest charges.

The main impounding reservoir is formed by the construction of the great Hetch Hetchy dam across the gorge of the Tuolumne River at a point high up in the Sierra Nevada Mountains about 150 miles east of San Francisco. From this point the flow will be for 12 miles through the original river channels, thence through 66 miles of tunnels 10 feet 3 inches in diameter, and 88 miles of steel pipes whose sizes have not yet been definitely determined, but will be probably 5 feet to 5½ feet in diameter.

In its early stages the plan was subject to con-

tinued and violent opposition and the location of the system, mostly at a high altitude in very rough and mountainous uninhabited regions, inaccessible at first by any means of rapid, efficient communication or transportation, greatly increased the difficulties, expense and necessary time of construction. To meet these difficulties and provide for the most economical construction and maintenance and for the absolute safety and continuity of operations in the finished structure, unusual care was exercised in the design not only of the permanent structure but of the auxiliary and temporary structures and of the methods of construction that were intended to utilize potential resources and advantages and the most advanced practise and resources of the various engineering construction problems involved. The general features of the system were described and a topographical and sectional map showing the principal structures was given in the Municipal Journal Vol. 45, page 223, Sept. 21, 1918.

PRINCIPAL AND AUXILIARY CONSTRUCTION.

The most important and difficult part of the work consists of the Hetch Hetchy impounding dam and reservoir; the 18-mile main tunnel under continuous high peaks of the Sierra Nevada range; the main power house on the conduit, and the pipe line connecting the latter with the tunnel, together involving an outlay estimated about $20,000,000.

GRADE OF MOUNTAIN HIGHWAY NEAR LINE OF AQUEDUCT AND RAILROAD.

The Hetch Hetchy dam of Cyclopean concrete is to be a gravity section, arched in plan, with deep foundations on solid granite rock and ultimately 312 feet high above stream level. Initially it will be constructed to a height of 226 feet above stream level, at a cost of $6,000,000 and should be completed to this initial height in 1922.

From the dam to the east portal of the main tunnel, water supply will be delivered through about 12 miles of the original channel of the Tuolumne River. Near the east portal there will be eventually established, at Early Intake, a power house to be connected with the Hetch Hetchy dam by 12 miles of pressure tunnel aqueduct, and a battery of steel pipe penstocks.

From Early Intake to Priest the water supply will be carried through a hard rock concrete lined tunnel 10 feet 3 inches in diameter and 18.3 miles long, of which the two main portions passing far below the summits of the peaks are connected by a short steel conduit crossing the south fork of the Tuolumne River between two high mountains. This tunnel descends 150 feet in its entire length thus conforming closely to hydraulic grade, and discharges into a regulating reservoir from which the water descending about 1,300 feet passes through a tunnel, a reinforced concrete conduit and steel pressure pipes to the Moccasin Creek power house of 66,000 h.p. capacity, and is then conveyed to San Francisco through about 69 miles of tunnel and 67 miles of steel conduits. By the completion of Moccasin Creek power house, the electrical energy available for San Francisco will be more than doubled. This will aid the industrial development of the city and the bay communities, which are now seriously hampered in their growth by lack of water and inadequate supply of power. Shipbuilding and manufactories of every description will be greatly stimulated.

FUTURE POWER UNITS.

An output exceeding 250,000 horsepower will ultimately be developed on the Hetch Hetchy project by dropping the water from the higher levels 8,000 to 10,000 feet altitude to the domestic supply terminal at Priest's, 900 feet above the sea level, as the city controls a watershed for its exclusive use of 416,640 acres, with an average runoff of two and one-half feet per year, which yields 1,041,600 acre-feet annually.

In order to transport plant and materials to the line of the work, the city has built a construction railroad about 68 miles long, connecting the Hetch Hetchy dam with the Sierra railway at a cost of about $2,000,000.

To provide electric power for construction operations, a preliminary hydroelectric installation has been built with a power house near the east portal of the main tunnel, at Early Intake with 4,000 h.p. capacity and transmission lines extended in both directions, one to the Hetch Hetchy dam and the other across the mountains paralleling the main tunnel to Priest.

Water under pressure to operate the turbines in the power house is derived from a reservoir constructed by building an impounding dam across the Eleanor creek to maintain the service in dry seasons and by conducting the water through Eleanor creek and Cherry River to a diversion dam and through an aqueduct consisting of tunnels, open canal and flume that delivers water with a head of about 346 feet to the power house, the whole installation, including Eleanor dam and the transmission lines, having been built at a cost of approximately $800,000. The Eleanor dam and the aqueduct will remain permanent features of the project.

HETCH HETCHY RAILROAD.

The 1915 report of M. M. O'Shaughnessy, chief engineer of the City of San Francisco, estimated that there would be required for the construction of the Hetch Hetchy dam and the upper tunnel aqueduct 233,000 tons of equipment and material,

chiefly cement, and that the cost of transporting it by motor trucks from the nearest point of the existing Sierra railway would be $3,095,000, or that it could be transported by rail over a special road at a comparative cost of $2,010,000, thus effecting a saving in transportation of $1,085,000 which could be realized by the construction of a railroad having great additional value for expediting the work, developing the resources of the country and earning freight on commercial business.

As the transportation of cement by motor trucks at that time involved double sacking it, at a cost of 11c extra per sack, and there was danger that, notwithstanding this precaution, considerable loss might be sustained and controversies arise, it was decided to build the railroad at the earliest possible date and defer as much of the construction as possible until after it was completed and in service to deliver the necessary plant and materials.

The route was surveyed and the construction supervised by six engineering parties that of course provided the data for all line and grade work, the location of structures, and supervised the building of culverts, trestles and bridges. In June, 1915, the location survey was completed on the present line 67.63 miles long, extending eastwardly from Hetch Hetchy Junction on the Sierra railway to the Hetch Hetchy dam site over a very crooked course as it follows the contours of the hills and mountains through the rough country where previously only a trail existed.

UNLOADING RAILS AT RAIL HEAD OF SERVICE RAILROAD.

At the western end of the line the road drops 310 feet in 9 miles and crosses the Tuolumne River 12 feet above high water on a bridge having a 220-foot steel truss span and 40-foot deck plate girder approach spans.

The railroad being designed to serve also as a common freight carrier passes through all of the towns likely to provide business for it and winds through the rough country with many sharp curves having a maximum of 30 degrees and many of 18 to 26 degrees. The maximum grade is 4 per cent and the adoption of these limits and the great care used in location cut the cost of construction remarkably low.

The contract for the construction of the roads for $1,543,080.74 was awarded to S. Rolandi, San Francisco, was certified by the auditor Feb. 15, 1916 and the road was completed sufficiently to carry traffic in May, 1917, and put in immediate service. The difference of elevation between the highest and lowest parts of the road is 4,400 feet and the nine miles at the eastern end pass through extremely rough country where in many cases the road bed was terraced on the sides of almost vertical rock cliffs.

The road is of standard gage with 60-pound rails laid on rock ballast, and has a roadbed 16 feet wide at subgrade except for nine miles in the Hetch Hetchy valley, where it is increased to 22 feet. Embankment slopes are 1½ horizontal to 1 vertical. Grading required about 1,000,000 yards of excavation, more than half of it being granite, solid rock and soft rock.

Alternate bids were invited on classified and unclassified materials, and the contract was awarded on the latter basis at a rate of 67c per yard for all kinds of material. The road was constructed with an average force of 600 men. Tracklaying was done by hand, the rails being unloaded from the platform cars of the construction train by several pairs of men lifting them with rail tongs and advancing them over the end of the forward car on standing rollers.

The character of the grading required is illustrated by the accompanying view of a road leading to the south fork tunnel portals which although not a portion of the regular construction railroad indicates the character of the country through which the latter passes.

OPERATION.

The road is operated by the city, directed by the city engineer as general manager and the first assistant city engineer as assistant manager.

The rates charged for public transportations were intended to cover the interest at 4½ per cent on the construction cost and to provide an amortization fund. On this basis the charge was fixed at 7½c per mile for passengers and 12½c per ton mile for freight in carload lots.

The entire water system and the auxiliary and supplementary works were designed and their construction is being carried on under the direction of M. M. O'Shaughnessy, city engineer.

Asphalt Pavements in Buffalo

Buffalo is a severe city on asphalt pavements. The temperature ranges from 14 degrees below zero in winter to 95 degrees above zero in summer, according to the latest U. S. Weather Bureau report. Nevertheless, Buffalo has in existence today some of the oldest asphalt pavements in the United States. Bryant street, laid with Trinidad Lake Asphalt in 1881, thirty-nine years ago, is in perfect condition today, having cost only $0.03 per square yard per year to maintain.

The total yardage of all asphalt streets in Buffalo is 4,838,792 square yards.

The total yardage of Trinidad and Bermudez Lake Asphalts is 4,374,041, or 90.5 per cent of the total yardage.

Stream Gauging Methods and Uses

The Naugatuck River, in Connecticut, was gauged by methods adopted to special conditions, the run-off estimated from long-time records on a similar watershed, and on the basis of this was calculated the advantage of equalization by storage, from the point of view of both sanitation and water power.

Some months ago a survey was made of the principal streams in Connecticut, which was carried out along four lines of investigation. The first of these was a measurement of the flow of the stream in connection with a chemical and bacteriological examination of the water, for the purpose of ascertaining the extent of pollution under known conditions of flow. The second, a determination of the average flow for the purpose of estimating the developed water power of the mills and the quantity available for storage. Third, the effect upon the flow of the stream of storing water during the high-flow months and letting it down so as to equalize the flow during the low-flow months; the extent to which such equalized flow would improve the sanitary condition of the river and add to the present developed water power; and the estimated value of such additional water power. Fourth an investigation of reservoir sites to ascertain to what extent water could be impounded and the probable cost of such development.

The study of the flow of the Naugatuck river, together with the run-off of its drainage area, was made under the direction of Charles A. Ferry of New Haven.

For ascertaining the flow of the stream, five guaging stations were established, located at points where the river was fairly straight for a considerable distance both above and below the station, and where the banks were high and the cross-section of the river was fairly uniform and free from obstructions that would create eddies and cross currents. These stations were equipped with Sanborn automatic recording guages, which gave a continuous record, for seven days, of the height of the water above certain fixed points. Two of these recorders were designed to give readings for a difference of elevation of five feet, and the other three for differences of ten feet.

CROSS-SECTIONING THE RIVER.

As the water was too deep in places to admit of wading and as no boats were available, cross-sections of the channel were made by means of a sounding lead suspended from a wire stretched across the river and anchored to deadmen on the banks. This sounding lead was supported by a light chain made with half-inch links running through a pulley, which was made to slide along the wire by means of an endless cord passing through screw-eyes screwed into the deadman. Every sixth link was indicated by a different colored piece of cloth; and by noting, with the aid of a transit, the color of the first cloth above the water surface and counting the number of links between it and the surface, the depth of water at each point could be ascertained. The pulley referred to was moved from point to point on the cable and the sounding lead lowered at each point, and in this way an accurate profile of the bed of the river was obtained. The location of the pulley each time was determined by means of a 200-foot steel tape, the end of which was fastened to the pulley and the reading taken at the zero point on shore.

Velocities were obtained by means of a current meter lowered by the same apparatus, but in this case there was, in addition, the cable from the meter to the telephone receiver, by means of which the revolutions of the meter were counted. Current meter measurements were made for different stages of the river, and from these measurements rating curves were constructed for each station, and from these were computed the daily flows as indicated by the recording charts.

RAINFALL.

So far as known, no previous records of the rainfall from the Naugatuck water-shed had ever been made, and in the estimate of average seasonal and other stream-flow quantities, other watersheds in the vicinity where long-time records of this kind had been kept, were consulted. Those of the Croton shed appeared to be most nearly similar to the Naugatuck. The sheds are only a few miles apart, are of approximately of the same size, both lie in the path of the storms coming from the west, the topography of the two is very similar, although the sides of the Naugatuck valley are somewhat steeper than those of the Croton, and the conditions as to cultivation are about the same.

Accurate rainfall and runoff records have been kept on the Croton shed for fifty years, and rainfall records have been kept in the Naugatuck valley for thirty-one years. Comparing the records for this thirty-one-year period, we find the average rainfall in the Naugatuck valley to be 48.24 inches, and in the Croton valley 49.61 inches. Comparing the records by months, the similarity is still more striking. In three of the twelve months, the average difference for the thirty-one years was only .01 inch, and in seven of the twelve months was less than 0.1 inch. The maximum difference in any one month was in July 1897, when the rainfall on the Croton shed was 18.1 inches and on the Naugatuck, 12.49 inches.

Rainfall records have been kept on the Naugatuck shed by the Waterbury Water Department for sixteen years, and these show for the Naugatuck and Croton sheds respectively rainfalls of 46.32 and 47.64, runoff of 23.23 and 24.64, and percentage of runoff to rainfall of 50.2 and 50.9 respectively. Mr. Ferry concluded from the similarity between these records and conditions, that the Croton rec-

ords for fifty years past can be employed with fair reliability in estimating the average flow of the Naugatuck river.

RUNOFF.

For the purpose of studying available power on the river, *ordinary* runoff flow was desired. For estimating ordinary flow, two rules were available, one by Desmond Fitzgerald and one by Professor Rankine. The former rule is to take the flow of the months above the average rate as being at the average rate, add to these the months below the average, excluding the lowest flow month, and divided by the whole year. Professor Rankine's rule is to arrange the discharges, observed daily, in order of magnitude without regard to date; divide this into an upper quarter, middle half and lower quarter; substitute the average of the middle half for the months of the upper quarter, and then take the mean of the whole list.

Using Fitzgerald's rule, modified to give ordinary *monthly* flow, it was found that the average flow was 21.10 cubic feet per second per square mile and the ordinary flow was 16.14; also that in September the average was practically double the ordinary, while in March it was only about 18 per cent greater, these being the extremes of variation.

The problem of the ordinary flow of this particular river is complicated by the presence of numerous storage reservoirs which tend to equalize the flow of the stream to a considerable extent. Six cities in the water-shed have public water supplies with storage reservoirs, the water from which eventually reaches the river through the city sewers.

To conserve the runoff from the 56.3 square miles of water-shed included in certain proposed developments so as to equalize the flow of the river during the eight low-flow months would require a storage capacity of 1,900 million cubic feet. Were this provided and the discharge regulated so as to equalize the flow, the average July flow at Waterbury would be increased from 110.3 to 280.9 cubic feet per second, and the average velocity from 0.63 to 1.1 feet per second.

SANITARY CONDITIONS.

Even the latter velocity would be insufficient to prevent the deposit of sludge in the river, and it is doubtful, therefore, whether the plan of establishing conservation reservoirs would have any marked effect in improving the sanitary condition of the river. If there should be any improvement it would be due to increased dilution rather than to scour or rapid removal of the sewage.

It was suggested that sanitary conditions might be benefitted by drawing off the water from the reservoirs for eight to twelve hours per day for the six working days instead of continuously. This method would temporarily increase the volume and velocity, but it is doubtful if this would be sufficient to prevent the depositing of sludge or to flush out the stream bed, while the intermittent flow would result in sludge being deposited on the banks of the stream and on sand bars with the daily resurrence of receding of the water. These deposits, exposed to the sun, would create a nuisance, which would probably offset any benefits from flushing.

Considered from the point of view of power, the equalization of flow presents an entirely different aspect. Most of the mills are provided with supplementary power, either steam or electricity or both, for use in time of deficient stream flow, and the value to them of the additional flow drawn from the reservoir would be simply that of the saving of coal or of electricity which would be effected. Assuming the value of one cent per horse power per hour, the total saving to the mills on the Naugatuck, as at present equipped, would be about $43,000 per year, if the 1,900 million cubic feet of storage were fully developed. This figure is based on a 24-hour run; with only eight or ten-hour runs per day, the saving would be much less. Some of the mills utilize only 0.32 cubic feet per second per square mile of tributary water-shed, while others use 3.82 cubic feet. Consequently the value to the mills of the proposed conservation plan would vary greatly—even more than is indicated by these figures, since the mills using the smallest amount would have sufficient water to run full time continuously except in periods of unusual drought.

Cost-Plus Contracts in Paving Streets

Among the questions making up the questionaire which we sent out a few weeks ago in collecting data concerning pavement construction, was one asking: "Did you employ cost-plucs contracts for any work? If so, what form of contract?" On account of the discussion which had appeared during 1919 in most of the periodicals which dealt with contracting in any way, it seemed to us probable that a number of cities had tried the cost-plus method, and that these and others would be interested in learning of experiences with it. We found, however, that only a very few cities had actually made use of this form. Such information as was given concerning its use is presented below.

Several cities stated that they had used it for paying for extra work done in connection with regular itemized-bid contracts. Aside from these, only seven cities reported using cost-plus contracts on paving work. Auburn, Maine, used cost plus 15 per cent; Fayetteville, North Carolina, for resurfacing old macadam, used cost plus 15 per cent; West Homestead, Pa., used cost plus 15 per cent for grading and paving; Providence, R. I., used cost plus 15 per cent; Columbia, S. C., cost plus 10 per cent; San Antonio, Tex., cost plus 10 per cent for grading.

Selma, Ala., used cost plus 15 per cent for sidewalks, and Ogdensburg, N. Y., used cost-plus form for curbing, the percentage not being stated. Fort Scott, Kansas, reported using this form (percentage not given) with strict supervision.

A few cities reported its use for work other than paving. For instance, Hibbing, Mont., uses cost plus 10 per cent for sewers; North Braddock, Pa., used a cost-plus contract for relaying sewers; Fairmont, W. Va., used it for bridges, and Houston, Tex., used it. From Ohio it was reported that it was against the state law for cities to employ the cost-plus form of contract.

Resurfacing Asphalt Pavements in New York

City forces remove about half an inch of the worn and deteriorated wearing surface without injuring the remainder, and replace it with new asphalt thoroughly welded on by 16-men gangs who averaged 1,450 square yards in 8 hours at a cost of less than $1.00 per yard for the 183,000 yards resurfaced in 1919.

In Manhattan Borough, New York City, 183,000 yards of worn asphalt pavement were resurfaced in 1919 at a cost of less than $183,000. The worthless material in the top of the old pavement was removed, without injuring the asphalt underneath, by the use of a hot air machine to soften it. The dead and injured old surface was removed down to unimpaired material and a thin layer of hot asphalt was perfectly welded to form a continuous new wearing surface that was applied as in original construction at a monthly rate of about 1,400 yards per day.

In Manhattan Borough nearly all of the streets, except in some of the most remote districts, have been paved for years; so long, in fact, that there is a large amount of pavement so much worn that it requires renewal or repairing that constitute the bulk of the paving work now executed there. Large quantities of sheet asphalt and block asphalt pavements are resurfaced every year, using the old base and generally part of the old top, but providing a new wearing surface. For several years this work has been accomplished by the heating method with which, during the year 1918, 151,000 square yards were surfaced and during 1919 183,000 square yards were surfaced at the cost of less than $1.00 per yard. This method is used on the streets having a concrete foundation covered with asphalt which is not yet worn out and which has not lost its life, but which has an irregular surface.

The essential features are the heating of the surface enough to soften it and permit the removal of about one-half inch of its thickness without injuring the good material beneath, and the application of the regular asphalt wearing surface laid smoothly and accurately, without visible joints, and thoroughly welded to the old asphalt.

HEATING AND REMOVING SURFACE ASPHALT.

The work here described does not include the ordinary patching or resurfacing of small areas of the surface enclosed by good pavement on all sides, but applies to the construction of an entire new surface usually in lengths of one or more city blocks, which is executed while traffic is excluded from that part of the street. The work is all done by city force account under direction of the Department of Public Works, C. M. Pinckney, chief engineer, W. E. Dey, division engineer. The quality of materials, workmanship, and paving operations conform to the specifications for regular asphalt pavement made with a binder course and an asphalt wearing surface having a thickness of 1½ inches when compressed. The asphaltic cement is mixed at the heating plant under the direct supervision of the engineers.

The first operation is the heating of the surface, which is done with a Lutz machine that eliminates the contact with the asphalt surface of a direct flame that cannot be accurately controlled and is likely to injure the good portion of asphalt.

The locomotive machines are provided with a steam boiler, an air chamber and a blowing apparatus that forces the large volume of air at a high temperature and at a uniform, moderate pressure adapted to secure best results through the blast pipe at the forward end of the machine, which terminates with an adjustable pyramidal hood having a 6 x 4-foot horizontal bottom opening. In service this opening is kept close to the pavement with just sufficient clearance to allow for the escape of the hot air. It is kept in one position long enough to soften the old asphalt to a depth of ½ inch to ¾ inch, an operation which usually takes from one to two minutes, after which the hood is elevated a few inches by the power attachment and is moved to an adjacent section of the pavement which is heated, and so on.

It is advantageous to use two heaters together, thus enabling the work to be prosecuted continuously, care being taken to coordinate the heating and removal of the damaged asphalt to correspond with the delivery of the new asphalt, so that the full sequence of operations is uninterrupted, and a continuous monolithic surface without joints is secured.

REMOVING OLD ASPHALT.

As soon as the hood is moved off from one position over softened asphalt, the latter is removed by rakers using heavy hoes made entirely of steel, with a 6 x 8 x ¼-inch blade having teeth about 1½ inches wide. All of the worn or injured material is raked off, to a depth of usually one-half inch to three-quarters inch, leaving a smooth, regular surface of live asphalt at a temperature of about 200 degrees. The asphalt that is removed is raked into piles that are immediately hauled away by two or more trucks or, if necessary, temporarily stored on the sidewalk. If any depressions below the general surface exist, they are filled with asphalt or sometimes with binder and the surface leveled and smoothed to receive the sheet asphalt.

APPLYING NEW SURFACE.

The wearing surface is of the standard type, composed of asphaltic cement and sharp sand

THE CITY OF NEW YORK
DAILY TIME REPORT FOR GANGS

PRESIDENT, BOROUGH OF MANHATTAN *Date* _____ *191*__
Department of Public Works *Gang No.*_____

No.	NAME	OCCUPATION	A. M. ARR.	A. M. DEP.	P. M. ARR.	P. M. DEP.	Hours on Duty: Jobless	Hours on Duty: Not Assigned	Hours Absent: Excused	Hours Absent: Not Excused	Description and Location of Work	REMARKS
	Victor F Hogan	Fore.Of.A.W.										
	Edward L McGrane	S.R.Engineer										

I HEREBY CERTIFY that the men whose names appear above worked under my direction and that the record of their services hereon is correct.

*Signature*_____

*Approved*_____ *Title*_____

delivered from the city yards where they are mixed. The sand, limestone dust, and asphaltic cement are heated separately to a temperature of approximately 325 degrees Fahrenheit and are carefully proportioned by weight, thoroughly mixed, delivered from the yard to the street in a suitable covered truck, and are spread on the warm surface of the thoroughly raked old pavement, raked to the proper surface, rammed adjacent to track rails and boxes, and finished with a steam roller.

Particular care is taken to insure delivery of the hot asphalt quickly and regularly so that no visible joints will occur between successive batches. The work is done with such care and skill that excellent results and a very satisfactory surface are obtained, not only with the sheet asphalt pavement, but with the block asphalt pavement, which is much more difficult on account of the larger proportion of aggregate which it contains.

EQUIPMENT AND WORKING FORCE.

The equipment consists of the usual asphaltic tools and apparatus, including fire wagons for heating of tampers, shovels for hot stuff, tampers and smoothers, rakes, hoes, asphalt picks and axes, and eight to twelve-ton steam rollers for compressing the hot asphalt with a load of 200 pounds per square inch. The amount of rolling varies, about 1,500 yards per day being considered satisfactory for one machine. Cannel coal is burned in the grate of the fire wagon because it makes less smoke and soot, and is found to be no more costly than soft coal. During the first half of the year 1919, the regular asphalt gang consisted of one foreman at $6 per day, one roller man at $6, two rakers at $4.50, two tampers at $4.25, four shovelers at $3.50, three asphalt laborers at $3.25, one two-horse team and driver at $8.50 (working part time) and one operator at $6.

The average day's work varied from about 1,400 to 1,500 square yards. During August, 1919, one gang laid 36,200 square yards in 26 working days. The season commenced in May and ended in November. For a resurfacing from 1¼ to 1½ inches thick, about 1 1-10 cubic feet of material per square yard is required, and the cost of 94 cents includes labor on streets, 19 cents, fuel 3 cents, rent of heater (use of machine only without operator, fuel and supplies) 5 cents, materials delivered 64 cents, supplies and overhead 3 cents. The rate for 1919 was about the same, but for the latter half of 1919 it was increased, probably about 2 cents per square yard. In the material cost are included all materials charges, plant depreciation, repairs, fuel, labor, hauling and interest.

YARDS AND EQUIPMENT.

The principal city yard, on the East River at Avenue A, 90th and 91st Streets, occupies an area of abou 200 x 600 feet. with accommodations for the asphalt plant and garages for all the trucks and automobiles of the Department of Public Works. There are repair shops for all the machinery and other plant, storage sheds for rollers, wagons and trailers, and storage piles for sand and gravel which are recived on barges that are unloaded by clamshell buckets operated by derricks.

The asphalt is delivered in bulk from lighters, where it is kept hot so that it can be pumped into five elevated steel tanks of 20,000 to 40,000 gallon capacity, where it is kept liquid by steam coils. There are corresponding mixing machines and delivery wagons for preparing and distributing the binder and the surface asphalt, giving the plant a capacity for 3,000 yards of completed asphalt pavement with top and binder, which, plus the 1,000 yards output for ten repair gangs, makes a

THE CITY OF NEW YORK
BOROUGH OF MANHATTAN

BUREAU OF HIGHWAYS
DIVISION OF MAINTENANCE REPAIR

DAILY MATERIAL REPORT _____ 191__

QUANTITIES RECEIVED

	TOP	BINDER	ASPHALTIC CEMENT	WOOD	PORTLAND CEMENT	KEROSENE OIL	EGG COAL	CANNEL COAL	ENGINE OIL	CYLINDER OIL	GREASE	WASTE
UNIT OF MEASURE	BOXES	BOXES	LBS.	STICKS	BAGS	GALS.	LBS.	LBS.	GALS.	GALS.	LBS.	LBS.

JOB NO

QUANTITIES USED

	TOP OR BINDER SENT DUMP BOXES	BOXES	BOXES	GALS.	STICKS	BAGS	GALS.	LBS.	LBS.	GALS.	GALS.	LBS.	LBS.
TOTAL													
PRICE													
AMOUNT													

DO NOT USE PRICE OR AMOUNT COLUMNS

total capacity of about 4,000 yards per day. Besides this plant, there are several smaller plants located at different parts of the borough where materials and equipment are stored for small repair and patch work.

The resurfacing is done by two regular gangs of twelve to fourteen men each, including about two rakers, two tampers, two cutters, one top shoveler, one smoother, three asphalt workers, one foreman, one roller engine man, besides which a two-horse team is occupied part of the time in hauling away waste.

The asphalt yard is under the direct control of the chemical laboratory which continually watches the quality and proportions of materials that are frequently sampled and tested and are constantly inspected by an assistant always maintained at any contractor's plant, where work for the city is being done. The specifications here require a finer sand than is used in most cities, thus obtaining a denser and more durable mixture.

RECORDS AND REPORTS.

As all of the new asphalt work is done by contract with guarantee, very accurate records are kept of the condition of the surface, of the wear and tear of which detail reports are filed on inspection form No. 2, herewith reproduced.

For each job of resurfacing work, a serial order number is given to the foreman in charge, who hands in daily reports of labor and material on blank forms giving all the data that, when posted up, shows the classified cost.

TYPICAL JOBS EXECUTED.

One of the largest jobs during the year was the laying of 92,800 square yards of new surface in Seventh Avenue between 100th and 153rd Streets, to repair asphalt block pavement laid in 1908 and guaranteed until 1913. In 1915, the percentage of repairs was 6 per cent; in 1916, 17 per cent; in 1917, 3 per cent. By 1919 the surface had become very irregular and humpy, making travel decidely uncomfortable. The blocks were found not to be generally worn through any more than to correspond with the percentage of repairs, but the whole street was full of humps and hollows. The traffic was light and largely consisted of automobiles with soft tires, estimated to amount to between 50 and 75 tons per foot of width of pavement per 10-hour day. This is considered a fair example of the asphalt block pavement work done in 1918.

Another important job was resurfacing Fourth Avenue from Twenty-third to Thirty-second Street, where 11,000 square yards which were paved in 1910 with a guarantee that expired in 1916. In 1915, there were made 8 per cent. of repairs; in 1917, 22 per cent., and in 1918, 27 per cent. The traffic was very heavy, with a large proportion of steel tires, and amounted to between 100 and 115 tons per foot of width, per 10-hour day.

WEAR AND TEAR REPORTS.

Detail records of the physical condition of the pavement are prepared from the inspector's daily slips made out on forms printed on 4⅝ x 6 inch sheets, and ruled with eleven vertical columns and thirty horizontal record lines besides the headings, and the totals at the top and bottom of the page. The first vertical column is headed ITEM NUMBERS, which are printed from 1 to 30, one on each horizontal line. The second column is headed DISTANCE ALONG CURB; third, CURB; fourth, DISTANCE FROM CURB; fifth to eighth, DIMENSIONS; the fifth and sixth being LENGTH; and the seventh and eighth, BREADTH; the ninth and tenth are headed AREA; and the eleventh column, which is rather wide, is printed on lines parallel to the vertical ruling with spaces titled respectively, STREET OR AVENUE, FROM, TO, STREETS OUT OF GUARANTEE, and KIND OF PAVEMENT. This column also contains the titles, CITY OF NEW YORK, BOROUGH OF MANHATTAN, DEPARTMENT OF PUBLIC WORKS, BUREAU OF ENGINEERING, INSPECTION FORM NO. 2, and the caption, WEAR AND TEAR REPORTS, ORDER NO. At the foot of the page there are lines for TOTAL SQUARE FEET and TOTAL SQUARE YARDS, and underneath them, "I hereby certify that the pavement at the.....locations stated herein has been repaired in accordance with the specifications and that the measurements as shown are correct.

.....191 .....
Inspector."

The work is in charge of C. M. Pinckney, chief engineer, Bureau of Engineering, Department of Public Works.

Unusually Safe and Attractive Road Contracts Unappreciated

An official communication from Madison, Wisconsin, announces a remarkable indifference on the part of local contractors to the efforts of the state officials to promote active road constructions by safeguarding the contractor and giving him unusually valuable estimating data.

Due to the fact that the Wisconsin Highway Commission has been allotted a certain amount of cement for use during the construction season of 1920, the Wisconsin Highway Commission has issued its circular letter No. 2, to Contractors and Material Companies and Machinery Companies, outlining certain road projects which will be given preference in the line of construction over any others and which will be advertised for bids from time to time.

On many of the jobs listed the plans are already completed and lettings have been, or are being held. To date about one-half of the work advertised has been let. In most cases the estimated quantities and length of projects are given and information is noted concerning physical or geological data, available materials or working conditions that are of unusual value to the contractor for making intelligent bids. Notwithstanding these advantages there has been a great scarcity of contractors bidding, apparently the contractors fearing the market conditions, and further, wanting to wait and see what prices the State would be willing to pay.

With the cement prices guaranteed and protected, and with the state paying for materials on the road, as the commission's new specifications call for, the commission fails to see where the contractor is making a very big gamble on the present conditions.

Skin Friction and Beaming of Piles*

Extended practical experience indicates that popular values for skin friction on piles are often too high; that horizontal earth pressures are usually much less than sometimes assumed, and that the center cores in hollow piles offer great resistance to pile sinking.

In the matter of the bearing value of soil at the base of deep foundations, especially caissons and piling, there seems to be considerable difference of opinion among engineers as to the relative value of bearing area and skin-friction. It has been customary for engineers to assume that soil at the foot of a pile is capable of sustaining only from 4 to 6 tons and crediting the remaining value of the resistence to skin friction. This resultant value for frictional resistance has, in numerous cases, been apparently checked by engineers in noting the resistance offered in pulling piles.

From observations of this character it has been common practice to give skin frictional resistance as high a value as from 1,000 to 2,000 pounds per square foot, and the writer is aware of instances in which it has been placed higher. The writer believes that it is not safe at any time to give a value to frictional resistance, unaided by taper or irregularities (projections, knots, etc.) higher than 50 pounds. His reasons for making this somewhat drastic assertion in the face of the foregoing statement are partially summed up in what immediately follows, and for which the writer must apologize for its somewhat elementary tone.

HORIZONTAL PRESSURES INVESTIGATED.

If a billet of wood, or plate of steel, be laid on in open box containing molding sand and the box be inclined until the plate or billet slides, the angle or coefficient of friction is at once determined. Assuming for the moment that this coefficient is found to be 40 per cent. of the weight or pressure; then, no matter how great or how small the loading thereafter, the superimposed material can always be moved horizontally by exerting a horizontal pressure equal to 40 per cent. of the weight of the material.

It follows necessarily that the frictional resistance of a smooth-bore pile sunk into material between which and the pile surface the coefficient of friction is 40 per cent., will have to resist a pressure of 5,000 pounds per square foot in order to develop a pressure of 2,000 pounds skin-friction. Considering the fact that a smooth-bore pile of ordinary dimensions (as one foot diam. or under) may frequently be withdrawn from the ground leaving the hole intact, the absurdity of crediting any such pressures to the superficial area of small piles is evident. It should be noted, however, that, as in tunnels, the larger the diameter the greater the pressure per square foot (in homogeneous soil), so in piles or caissons the greater the diameter the greater the pressure per square foot. It is thus possible to design a caisson whose superficial area will be so great as to prevent its sinking due to the tremendous frictional resistance per square foot; while a number of small caissons of a total equivalent bearing area but much larger superficial area in the aggregate would meet with comparatively small frictional resistance per square foot if sunk plumb. In this connection resistance due to insufficient clearing of the cutting edges; binding due to the caisson being out of plumb, etc., should not be confused with skin frictional resistance.

BEARING AREA.

A clearly defined line of demarkation should also be drawn between what is actually bearing and what is frictional area. The writer believes that this can be simplified by stating that bearing area constitutes the equivalent bottom area as well as all horizontally projected areas of taper and other large projections such as collars, bands, knots, etc.; while the frictional area consists of all vertical or approximately vertical areas—that is, horizontal area is bearing area and vertical area is frictional area.

It is readily seen that if the theory of the lateral transmission of pressure is sufficiently set up, that the bearing value due to the taper of a pile is a very considerable factor. If, for instance, we take a pile of 6-in. diam. at point and 12-in. diam. of butt (at effective depth) the bearing for the point is practically 0.2 feet, while the area of the taper is 0.585 feet.

The error due to computing the frictional resistance of a pile by the pull required to withdraw it, is frequently caused by the impracticability of pulling a pile without causing considerable binding due to the line of the pull not being in line of the piles axis.

As to his reasons for stating that frictional resistance has been rated too high, the writer cites the following notes:

CORE RESISTANCE.

(Note A) In the matter of sinking, under his direct supervision, several hundred steel cylinder piles 12 to 14 inches diam. and of practically smooth bore, he has always found that a pile driven to refusal by hammer or jack could be made to sink with comparatively light pressure as soon as the core of earth or obstruction down to the cutting edge was removed. Ordinarily it might be thought that the accumulation of a core of earth in a hollow pile could not materially effect its progress.

*Excerpt from paper presented to Brooklyn Engineers' Club on Deep Foundation and Piling.

It has been found, however, that in nearly all instances where this core has accumulated to a depth of 3 or 4 feet it compacts itself in the pile footing, being held in place by the lateral pressure against the sides, assisted somewhat by the nearest inside collar and because of the relative increase of friction with pressure it becomes as incapable of being dislodged by the downward pressure of the pile as though composed of concrete. 12 and 14-in. piles have frequently been noted under these conditions as resisting pressure from 60 to 90 tons and carrying down a core 2 or 3 feet deep and which when the core was removed sand redaily under the 6-inch drop of a 350 pound hammer.

(Note B) In the matter of sinking deep well casings it would be virtually impossible to do this if frictional resistance values ran as high as from 1,000 to 2,000 pounds. For instance, an 8-inch casing sunk 1,000 feet would develop at 2,000 lb. per square foot something like 2,000 tons resistance; whereas the maximum strength of the pipe, if extra heavy, would not be over 1,000 tons.

(Note C) In some of the early experimental work on Long Island the Board of Water Supply sunk a 12-inch smooth bore hollow steel pile more than 800 feet, using jacks whose maximum rating was 100 tons. It is stated that no special difficulty was met in sinking this pipe when it was fully cleaned out.

While it is not probable that the full force of the jacks was used or required, assuming that such was the case the maximum frictional resistance per square foot did not exceed 75 pounds.

TORSIONAL MEASURE OF FRICTION.

(Note D) It is frequently noted in sinking test borings that tubes or casing which can not be pulled without breaking (due probably to the binding, and to collar or couplings) can readily be turned with chain tongs by hand.

(Note E) It would appear then that a simple effective test of frictional resistance can be made by placing a cylinder in a box or bed of normally dry sand. The cylinder should have an axle throughout its length to insure equal stress in turning, and, if practicable, this axle should project beyond each end of the box or bed. By establishing the coefficient of friction and determining the resistance to turning, the frictional resistance may be found, as well as the pressure of the sand, on the pipe.

Bolshevik Strike Threats

The anthracite coal miners are announced to be preparing with incredible effrontery to demand on Mar. 9 an increase of 60 per cent in wages, a 6-hour day and 5-day week for an organization of about 170,000 men. The bituminous coal miners, following their conspicuously, reckless and unreasonable denunciation of the 14 per cent increase to their already high wages just granted them, are due to make further trouble about the 1st of April. The attitude of the railroad brotherhoods in their threatening demands for larger and larger increases of wages, their insolent attempts to coerce the government, and their threats to defeat Congressmen and Senators who dare to vote against their selfish and unwholesome propositions, together with the latest bluff of a shopmen's strike in hopes to hold up the railroad owners by embarrassing them with government action before the return of the property, all show clearly enough their determination to make their demands as confiscatory as the traffic will bear, and then some.

The whole system of forcing up wages to absurd and impossible levels simply because organized labor has political and industrial power and is disposed to use it ruthlessly, is the worst possible national policy, and if permitted to continue long enough can only end in self defeat. There is and can be no objection to the highest kind of wages provided they are *earned,* and most employers greatly prefer men who are worth a high price to those who are worth only a low price. The trouble lies in the fact that the high wages are rarely earned, and that the higher they grow, the more time and money the laborers have for various indulgencies, the more disinclined they are to work, the less able they are to work well, the less inclined to render an honest equivalent for their pay, and the greater the labor turnover.

Efficiency has decreased enormously, being conservatively estimated at only 30 to 60 per cent of what it generally was five years ago in this country. The tendency to greatly shorten the working days makes it very difficult to secure enough products to pay the fixed and overhead charges that must be met before any profits can be accrued or funds be provided for extensions and improvements. The 6-hour day and the 5-day week are utterly inadequate and absurd and an insult to civilization itself which cannot at this stage maintain decency and comfort, to say nothing of progress or safety, without a very much higher amount of efficient service from skilled and unskilled labor.

Record Road Construction in Pennsylvania

During 1919 the Pennsylvania State Highway Department of Pennsylvania completed the construction of 253.10 miles of durable highway and 41.58 miles of uncovered base, notwithstanding that the unusually rainy weather greatly interfered with the work of contractors during all of 1919. There was an average of 127 days of rain during the year in Pennsylvania. This meant that not only was the work of the contractor interfered with on the day of rain, but on subsequent days until the subgrade dried sufficiently to permit operations to resume. Reports received by the Department show that this mileage was not equaled by any other commonwealth.

During 1919 the State Highway Department contracted for the construction of 685.02 miles of durable roadway of various types. Contracts carried over from 1918 into 1919 totaled 95.47 miles. During 1919, 73.36 miles of the uncompleted 1918 mileage was finished and there remains to be done 22.11 miles. Of the 685.02 miles contracted for in 1919, 179.74 miles were entirely completed when contractors were compelled to shut down for the winter. A total of 3,316,306 feet of roadway is involved in contracts awarded during 1919.

Many miles of new roadway will be completed very early in the coming season.

NEWS OF THE SOCIETIES

March 8-9—INDIANA SANITARY AND WATER SUPPLY ASSOCIATION. Annual Convention at French Lick, Ind. Secretary-Treasurer, L. R. Taylor, French Lick, Ind.

March 8-10. INDIANA SOCIETY OF SANITARY ENGINEERS, Richmond, Ind. Secretary, Indianapolis, Ind.

March 10.—VERMONT SOCIETY OF ENGINEERS. Meeting and convention at Burlington, Vt., Secretary, George A. Reed, Montpelier, Vt.

March 10. THE NEW ENGLAND WATER WORKS ASSOCIATION. Meeting at Hotel Brunswick, Boston. Secretary, Frank J. Gifford, Dedham, Mass.

March 16-18. — AMERICAN RAILWAY ENGINEERING ASSOCIATION. Manhattan Building, Chicago.

March 24-25. NATIONAL WHOLESALE LUMBER DEALERS ASSOCIATION, Washington, D. C. Secretary, 66 Broadway, New York.

March 24-25.—NATIONAL FEDERATION OF CONSTRUCTION INDUSTRIES. The first annual meeting at Chicago. Executive Secretary, John C. Frazee, Drexel Building, Philadelphia, Pa.

March 24-26. SOCIETY OF INDUSTRIAL ENGINEERS, Bellevue-Stratford Hotel, Philadelphia. Secretary, 327 South La Salle St., Chicago.

March 25. NORTH CAROLINA PINE ASSOCIATION, Norfolk, Va. Secretary, Norfolk, Va.

April 12-17. — UNITED STATES GOOD ROADS ASSOCIATION. Eighth Annual Convention, Hot Springs, Ark. Director-General, J. A. Rountree, 1021 Brown-Marx Building, Birmingham, Ala.

April 16-17. — BANKHEAD NATIONAL HIGHWAY ASSOCIATION. Fourth Annual Convention, Hot Springs, Ark. Secretary, J. A. Rountree, 1021 Brown-Marx Building, Birmingham, Ala.

May 10-11.—AMERICAN ASSOCIATION OF ENGINEERS. Sixth Annual Convention, St. Louis, Mo. Secretary, C. E. Drayer, 63 East Adams Street, Chicago.

May 18-21.—NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention, Pasadena, Cal. Acting Secretary, S. A. Sewall, 29 West 39th Street, New York City.

June 22. JOINT COMMITTEE ON STANDARD SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE. Next meeting at Asbury Park. Secretary-treasurer, D. A. Abrams, Lewis Institute, Chicago.

National Federation of Construction Industries.

The Advisory Board of one hundred and fifty-three members representing all sections of the United States and all lines of construction and related business is favorable to the principle of the creation of a National Department of Public Works, but the following features of the bill are objected to:

The transfer of the Bureau of Education, Bureau of Indian Affairs and Howard University to the Department of Labor.

The transfer of the Forest Service from the Department of Agriculture to the Department of Public Works.

The fact that Assistant Secretaries of the Department of Public Works are not necessarily to be selected by the Secretary of Public Works.

The elimination of the Department of Labor.

At the convention of the National Department of Public Works Association, on Jan. 13 and 14, 1920, at Washington, the following resolutions, which have some bearing on the above objections, were adopted:

Section 3 of H. R. 6649-S, 232 (the Jones-Reavis bill) has nothing to do with public works. The only reason for its presence in the bill is that some departmental disposition must be made of the non-engineering bureaus in the Interior Department.

It is manifest that the numerous organizations which have become affiliated under the name of National Public Works Department Association for a common public works purpose do not, by so doing, commit themselves with respect to any other question, national or otherwise. Therefore, each affiliated organization may have and is entitled to express its views as to said Section 3 of the bill without in any way qualifying its approval of the remainder of the bill.

The National Public Works Department Association, as such, is therefore unable either to approve or to disapprove the specific assignments of bureaus in the said Section 3, and in advocating the bill before committees of Congress the agents of this association are to be instrusted to present this fact in an unmistakable way.

The National Public Works Department Association suggests to all affiliated organizations that they present to Congress thsir own individual views with respect to said Section 3, either through its legislative agents of this association or otherwise.

The first annual meeting of the Federation will be held at the Hotel Sherman, Chicago, Ill., March 24-25. Experience has disclosed the desirability of a number of changes in methods of working. The directors have presented amended by-laws, which are proposed for adoption at the annual meeting.

More than a year has ensued since the by-laws were adopted. Among the important amendments which are indicated to be desirable are a more exact definition of the purposes of the Federation, a revision of association membership dues, the admission to suffrage of individual members, an increase in the number of directors and revision of the method of their selection, an increase in the number of vice-presidents, the creation of the advisory board, provision for the staff council, and the development of district organizations.

Member Associations are requested to confer upon their delegates to the annual meeting power to act in the adoption of amendments to the by-laws, and to submit to the board of directors, through the secretary, not later than March 15, 1920, any desired amendments to the proposed by-laws.

Associations which are not members of the Federation are requested to send representatives to the annual meeting with power to make application for membership in the name of their association, and to furnish credentials conferring upon their representatives the power of delegates as soon as their association shall have been elected to membership.

Individual members are requested to submit to the board of directors of the Federation, through the secretary, not later than March 15, 1920, any desired amendments to the proposed by-laws.

JOHN C. FRAZEE,
Executive Secretary.

Texas Highway Building Association.

An organization of highway builders and others interested in the construction of good roads was effected at a convention of highway experts at Austin, Texas, which adjourned Feb. 21. Its purpose is the promotion of building of highways and to coordinate the various interests and agents that are directley interested in the building and promotion of highways.

The following officers were elected:

R. G. Tyler, professor of highway engineering, University of Texas, president; R. V. Glenn, of Fort Worth, Newman A. Gregory, of Texarkana, L. W. Kemp, of Houston, and County Judge E. M. Overshiner, of Taylor County, vice-presidents. The board of directors consists of the president of the association, the State Highway Engineer and Federal Engineer as ex-officio members, and J. C. Nagle, professor of engineering of A. & M. College; Judge Cecil Simpson, of Dallas, Ed Dennis, of San Antonio, and R. J. Potts, of Waco.

American Society Civil Engineers.
At the regular meeting, March 3, a paper on "The Light Railways of the Battlefront in France" was presented by Frank G. Jouch.

Am. Soc. C. E. Seattie Branch.

The Seattle Chapter of the American Society of Civil Engineers held their anual meeting Feb. 9, electing the folowing officers:

J. L. Hall, president; Maj. Carl Reeves, vice-president; Capt. B. D. Dean, secretary-treasurer. The evening was featured with talks by Col. J. A. Woodruff, corps of engineers, who described the work of the division of construction and forestry of the army in France, and Prof. C. C. Moore, of the University of Washington, who spoke on the engineers' camp at Camp Humphreys. A. H. Dimock, city engineer, discussed the Skagit River development work to be undertaken by the city.

Western Massachusetts Engineers.

At a meeting in Springfield Feb. 24 a paper on Street Lighting, illustrated by stereoptican slides was presented by W. E. Hodge, deputy in charge of Springfield lighting. An address, illustrated by moving picture films and slides, was given by John L. Hopper, vice-president and chief engineer of the Niagara Falls Power Company. The plans which this company operates and the original plant above the falls and the hydraluic power company plant on the American side and the Ontario plant on the Canadian side. The combined output of these plants, including three new 40,000 horse power units, produce the world's largest power output.

The New England Waterworks Association.

The March meeting of the New England Waterworks Association will be held at Hotel Brunswick, Copley Square, Boston, Wednesday, March, 10. Lunch will be served at the hotel. Tickets, $1.50. Papers will be presented on "Progress in Making an Established Waterworks Modern and Efficient," by Reeves J. Newsom, Commissioner of Water Supply, Lynn, Mass., and on "Atlantic City High Pressure Fire System," by Lincoln Van Gilder, engineer and superintendent Water Department, Atlantic City, N. J. The discussion on "The Efficiency of Pipe-Jointing Compound as Compared With Lead" will be opened by Fred O. Stevens, superintendent of Waterworks, Weymouth, Mass.

The rooms of the association, 715 Tremont Temple, are open for the use of members daily from 9 a. m. to 5 p. m.

PERSONALS

Dermott, W. J., has been appointed city engineer of Radford, Va.

Massie, Walter W., has been appointed city engineer of Cranston, R. I.

Head, Orrin W., has been appointed superintendent of streets of Concord, N. H.

Rice, C. E., has resigned as engineer of the City Planning Commission of Akron, O.

Phillips, F. E., has resigned as bridge engineer of the Montana State Highway Commission.

Kaltenbach, Charles J., has resigned as bridge engineer of the West Virginia State Highway Commission.

Marble, Arthur C., has resigned as city engineer of Lawrence, Mass.

Priestman, Robert W., has been appointed city engineer of Lawrence, Mass.

Morton, R. M., has been appointed engineer of the Highway Commission of San Diego County, Cal.

Evans, Kenneth, has been promoted from assistant construction engineer, Division of Highways, Illinois Department of Public Works and Buildings.

Davis, E. H., has been appointed chief engineer of the sixth district, Georgia Highway Department.

Marble, Arthur I., has resigned as city engineer of Lawrence, Mass.

INDUSTRIAL NEWS

Research in Alloys.

In an effort to obtain and present in concrete form information and data which will be of value to numerous industries of the country, the National Research Council, through the Division of Industrial Research, is organizing a co-operative association to carry on fundamental research in alloys. Scattered investigators have done much valuable work in this field, but a co-operative association composed of specialists representing both the manufacturers and the more extensive users of alloys can obtain and classify additional results of great importance.

It is, therefore, proposed to create a special scientific staff with a director and assistant director of research and a group of scientific investigators and technical experts who will devote their whole time to this work. Each member of the co-operative association will pay $1,000 to finance the organization, and all contributing members who may be either alloy manufacturers, using individuals, firms, or companies are to benefit alike by the results of the researches carried on by the association.

F. C. Austin Company Increases Manufacturing Facilities.

The combination of the Austin and Linderman plants increases eight-fold the capacity of the present Austin output, which gives this new company the largest capacity for earth-loading and cement-working machinery in the United States.

The F. C. Austin Machinery Co. is incorporated to take over the entire business of the F. C. Austin Company, Inc., the Municipal Engineering & Contracting Company and the Muskegon plants of the Linderman Steel & Machine Co., and retains the personnel of the companies whose combined efforts are directed towards supplying the demand for the Austin machines.

F. C. Austin retires from the active management, and the president of the Linderman Company, Mr. B. A. Linderman, assumes control.

Offices of the combination will continue in the Railway Exchange Building, Chicago.

Hendricks' Commercial Register.

The 28th annual edition of "Hendricks' Commercial Register of the United States for Buyers and Sellers" for 1920 contains several improvements. The most noticeable being the new method of exterior indexing by coloring the front edge red, white and blue to indicate the different sections of the book. The Trades Index is a section of 162 pages in which every product listed in the book is indexed and cross indexed for ready reference. The main classified trades list contains 1,813 pages, listing over 18,000 different products. The present edition has over 1,200 new headings, including many headings completely covering the chemical industry. The third section of the book contains 216 pages listing the trade names under which products are manufactured, with the name and address of the manufacturer. The alphabetical section of 487 pages contains all the names in the book in one alphabetical list with addresses, and their main line of business. This is followed by the index to advertisers of 20 pages, containing a full list of branch and foreign offices following each name. The whole book is a volume of 2,703 pages. The list of trade headings covers from the raw material to the finished article all products connected with the Electrical, Engineering, Hardware, Iron, Mechanical, Mill, Mining, Quarrying, Chemical, Railroad, Steel, Architectural, Contracting and kindred industries, and the firms listed cover Producers, Manufacturers, Dealers and Consumers.

NEW APPLIANCES

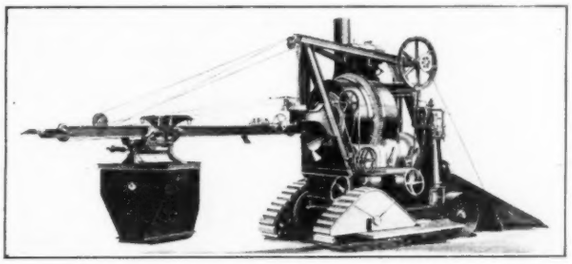
Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations.

Smith Simplex Paving Mixer.

In the Smith Simplex Paving Mixer, built by the T. L. Smith Company, there are only eleven gears used, although the paver is entirely gear driven with the exception of the chain running from the drive shaft to the wheels.

The entire operation of the machine is controlled by four levers and four control wheels all located within the easy reach of a man standing on the operator's platform.

Another feature of paramount importance to the contractor found only in the Simplex Paver is the possibility of firing it with either a boom-and-bucket or a chute delivery. The frame is so constructed as to accommodate either equipment, and the change can be made quickly—right on the job if necessary. The traction may be the wheel or the caterpillar type.



BOOM AND BUCKET PAVER WITH CATERPILLER TRACTION.

Steel castings have been used in many cases where the usual iron castings might have sufficed under ordinary conditions. The frame is made of tough steel channels which are heavily reinforced, and all of its strength requires surprisingly light weight.

Blaw-Knox Forms.

A small folder recently issued by the Blaw-Knox Co. illustrates the very wide range of concrete construction for which it provides special lines of concrete forms of standard type, most of them adjustable, that are either rented or sold, for almost all kinds of work.

Collapsible forms, the larger sizes being carried on travelers, are leased for the construction of tunnels, sewers, aqueducts, subways, culverts and similar work. For tunnel work there are also provided liner plates, flanged sections of rings that can be bolted together to take the place of timbering in soft ground.

Truss centers of structural steel are leased for erecting concrete bridge arches, and strong structural steel forms, provided if necessary with steel travelers for shifting and supporting them, are designed, fabricated and leased for the construction of dams, piers, abutments, retaining walls, reservoirs and other heavy work. Light wall forms are also available for grain elevators, coaling stations, reservoir walls, circular tanks and other purposes.

A separate booklet on Blaw forms describes the quick acting slip joint connection and illustrates the use of a standard form for all kinds of road and street work. Complete service in building construction is provided by the use of floor and roof slab forms and adjustable circular column forms which will be erected, shored and removed at a flat price.

Among the advantages of these forms are the rapidity and accuracy with which they can be set and removed, their reliability and freedom from warping, twisting and splitting. They are practically indestructible, and can be used repeatedly for years.

Saving Fuel Automatically and Scientifically in the Boiler Room.

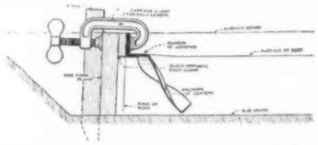
This is the title of a new 24-page booklet published by the Northern Equipment Co., Erie, Pa. It is based upon matter that was prepared for the United States Fuel Administration during the war. It thoroughly compares hand and mechanical feeding with mechanical regulation, as performed by the Copes Regulator. It shows in a convincing way what is to be desired in the way of scientific boiler feed regulation. Many charts and diagrams emphasize the value of scientific control.

Sterling Engines.

Sterling engines of the commercial type for pump and generator drives use gasoline fuel and are made with 4, 6 and 8 cylinders. Four sizes of 60 to 148 h. p. are designed for operating standard underwriters fire pumps delivering from two to six 1⅛-inch hose streams, or from 500 to 1,500 gallons per minute. They have electric starters, generators and batteries insuring power to immediately meet any emergency. G R 6-cylinder, 225-h. p. motors at 1,500—1,600 R P M are built primarily for swift express cruisers and very fast runabouts and conform to marine engine standards. They have detachable cylinder heads and overhead dual inlets and dual exhaust valves. The light weight averaging between 8 and 9 pounds per h. p. is made possible by the extensive use of forgings. Sterling engines are made in sizes up to 300 h. p. and it is intended to increase them up to 450 h. p.

International Paving Guard.

This device, intended to protect the edges of macadam roads or other paving, consists essentially of a horizontal steel angle with the horizontal flange cut and bent so as to form twisted anchors extending into the concrete foundation and holding the guard firmly in place.



PAVING GUARD CLAMPED IN POSITION DURING ROAD CONSTRUCTION.

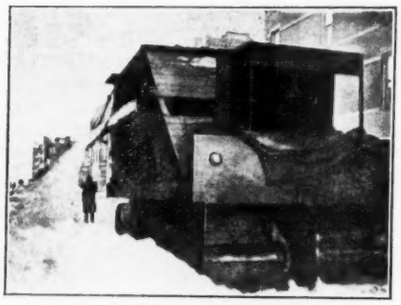
They are made from 2 x 2 x ¼-inch steel angles in 15-foot lengths with anchors formed 10 inches apart on centers. To install them, they are clamped or nailed to side forms or to stakes driven along the edge of the road, the upper edge of the angles being about ⅛ inch below surface grade.

Amco Segment Blocks.

Franklin G. Lynch, city engineer, Erie, Pa., reports favorable progress on the construction of an 8-foot circular sewer built under difficult conditions with Amco Segmental blocks.

Elevating Snow Excavator.

Among the devices used for removing the recent heavy icy snow fall from the streets of New York was a twenty-ton truck equipped with mechanism which enabled it to eat its way into a snowdrift, the snow being carried up into the truck body and then ejected down a chute to the gutter or to a smaller truck running alongside.



20-TON AUTOMOBILE EQUIPPED WITH SNOW EXCAVATING AND ELEVATING APPARATUS.

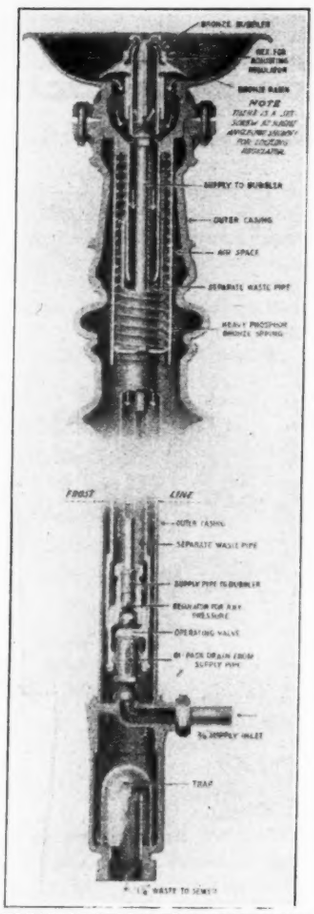
The National Snow Removing Company, owners of the truck, stated that the tests showed it capable of removing 9 cu. yds. of snow a minute, and able in a single day to do the work of 1,000 men. It is claimed to travel five miles an hour in from 3 to 4 feet of snow and will make a clearance of 11 feet wide, throwing the snow 20 feet clean of the truck. The machine is mounted on 40 x 12-inch United States solid tires, each made to carry a load of five tons.

New Iroquis Macadm Roller.

All parts of this machine are supported on a steel plate frame. The vertical boiler is a separate unit, to which no working parts are attached, which may be quickly and easily removed or repaired without disturbing the rest of the roller. The rear wheels are supplied with demountable rims which may be easily changed. The speed is governed by a differential gear like that of an automobile. It has a pilot steering gear, an adjustable steam scarifier, and belt-driven attachment for operating stone crushers and other plant.

Tiffin Motor Trucks.

These trucks, with worm gear drive, are made in 1½, 2½, 3½, 5 and 6-ton capacities and are equipped with four-cylinder motors, forced feed and splash system lubrication, centrifugal pump and fan cooling system, selective type transmission, Ross type steering gear and internal expanding service and emergency brakes. They are designed for use with 600, 750, 900, 1,000, 1,200, 1,400 and 1,500 gallon flushers.



VERTICAL SECTION THROUGH BUBBLE FOUNTAIN.

Murdock Patent Bubble Fountain.

This fountain intended for general use in streets, parks, outdoor places, mills, stations and many other public locations is simple, strong and durable and is recommended to school boards and mill owners. It drains automatically after each drink, is anti-freezing, anti-contagious and non-squirting.

The removal of three bolts enables the inner part to be lifted out from the strong outer casing that protects them. The self-closing feature saves water.

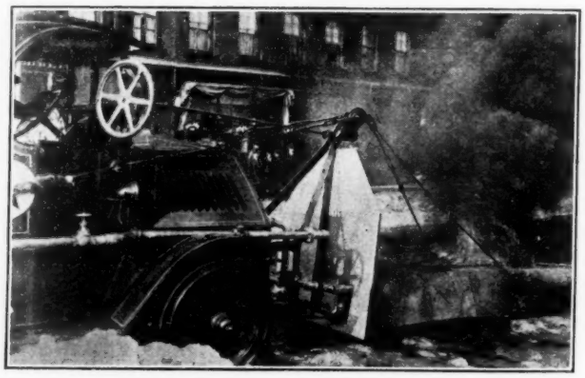
Safety Sanitary Rubbish Boxes.

These are made of heavy galvanized iron reinforced and are 20 inches square and 36 inches high, containing a burlap sack that, when filled, can be removed and replaced by an empty one in 10 seconds. They are made with four different tops, two of which are for use in streets and parks, permitting rubbish to be deposited in them from any angle and the other two operate somewhat like a mail box, and are used for factories and public buildings. In one city where 100 of these boxes are installed, the paper collected in them has been sold for more than $40 per week. They are manufactured by the Safety Sanitary Rubbish Box Co., who also make for city street cleaning department high grade steel pans 19 inches in diameter at the top, 15 inches at the bottom and 24 inches high, reinforced and provided with extra heavy handles.

Street Snow Melter.

One of the most novel of the devices offered for the removal of snow in city streets is the oil burning snow melter shown herewith mounted on a Mack seven and a half ton truck in use in Brooklyn, N. Y. It is the invention of L. V. Stevens, a Canadian engineer, and was first used successfully by the Canadian Pacific Railroad to clear its tracks.

The truck, which carries an 1,800 gallon tank of crude oil, travels at the rate of five miles per hour, belching an incandescent flame some ten feet ahead, collapsing snow banks as if by sun stroke. The oil and air are both forced ahead under compression through a mixer or carburetor, in a manner similar to the practices established in the case of blast furnaces and oil burning locomotives. Two pipes extend in front of the truck and crude oil from an 1,800-gallon tank on the truck is forced through the pipes while burning.



7½-TON TRUCK WITH FUEL TANK AND OIL BURNER MELTING SNOW IN BROOKLYN STREET.

Horse Maintenance In Pittsburgh

Average costs of keeping 446 horses in sixty-one municipal stables range from 18.5 cents per horse-day to 92.6 cents, averaging 68.5 cents. Figures are given showing the greater cost of keeping horses in active work than those of the Fire Department.

Through the courtesy of J. C. Slippy, chief accountant of the city of Pittsburgh, we have received some figures showing the cost of maintaining horses for the various municipal departments of that city. The figures are returned monthly and those given herein are a summary of these monthly reports for the six months ending June 30, 1919.

Sixty-one stables are included in the report and the total number of 81,538 horse-days is included in the statement—an average of 446 horses, or 7 1/3 per stable. Thirty-nine of the stables are in connection with fire engine houses, four are for police stations, six are for the Department of Highways and Sewers, three are for park service, and the others are miscellaneous.

The cost items are subdivided into "feed," "bedding," "shoeing," and others that are not itemized; each of these showing both the total cost and the cost per horse-day.

Under the head "feed," the cost per horse-day varies from a minimum of 16.6 cents at one of the fire engine stations, to a maximum of 78.5 cents at the filtration plant, there being three horses at the former and two horses at the latter. The greatest number of horse-days is found in one of the stables of the Division of Highways, which totals 8,393, and the cost of feed there was 70.6 cents per horse-day. The average cost per horse-day for all the stables was 56.2 cents.

Bedding costs varied from a minimum of 0.14 cent to a maximum of 9.2 cents; the average for all the stables being 3.2 cents.

The cost of shoeing varied from a minimum of 1.7 cents to a maximum of 12.9 cents. The average cost for all the stables was 9 cents .

The total cost of horse maintenance varied from a minimum of 18.5 cents to a maximum of 92.6 cents; the average for all the stables being 68.5 cents. This total includes other items not given in detail, but amounting altogether to 8.1 cents per horse-day.

HIGHER COST OF WORK HORSES.

All of the stables of the Division of Highways and Sewers and three of the Water Department show costs for feed much higher than any of the others, and the same stables with three others are considerable above the average in the cost of shoeing. The total costs were more than ten per cent higher than the average in the case of two of the park stables, all of those of the Division of Highways and Sewers and three of the Water Works stables. As this includes nearly all except those connected with the Fire and Police Departments, this higher cost would not necessarily tell against the departments named, for the reason that the engine horses receive comparatively little exercise except what is taken for their health; this also being indicated by the fact that the cost of shoeing these horses averages only about half as great as that of shoeing the horses of the Department of Highways and Sewers. It naturally and properly follows that the latter horses, which regularly do a strenuous day's work, receive more food and consequently run the cost of food higher than in the case of the Fire Department horses. This is indicated more exactly by the fact that the cost of feed for all of the engine horses averaged 43.4 cents per horse-day, while this item for the Department of Highways and Sewers averaged 66.8 cents, or 54 per cent greater.

The cost of bedding does not appear to bear any relation to the amount of service rendered, but probably is rather a function of the care and economy exercised by the several stable managers. As an illustration, among the fire engine companies alone there is a variation between a minimum of 0.7 cents per horse-day and a maximum of 7.4 cents per horse-day.

Paving Costs in Grafton

Grafton, W. Va., in 1916 laid Dunn wire-cut-lug brick on a four-inch base with 1½ inch sand cushion, using Carey's transverse expansion joints every 30 feet and longitudinal joints along each concrete curb. The contract price for this was $2.56 per square yard. At that time concrete cost $2.40 a barrel, sand $.75 a cubic yard, gravel, $.75 a cubic yard and labor $2 per day of eight hours.

No paving was done by the city between 1916 and 1919, but during the latter year the city laid 1,114 square yards of pavement similar in all respects to that laid in 1916, but the contract price was $3.54—practically $1 more than in 1916. Labor last year was receiving $3.60 for eight hours, cement was $2.97 a barrel and sand and gravel were $1 per cubic yard.

Taylor County, in which Grafton is located, is to vote on a $1,000,000 bond issue, and our informant, Findlay Barber, city engineer of Grafton, believes that it will carry, and about 2¾ miles of brick pavement with concrete base will be laid by the county within the city limits.

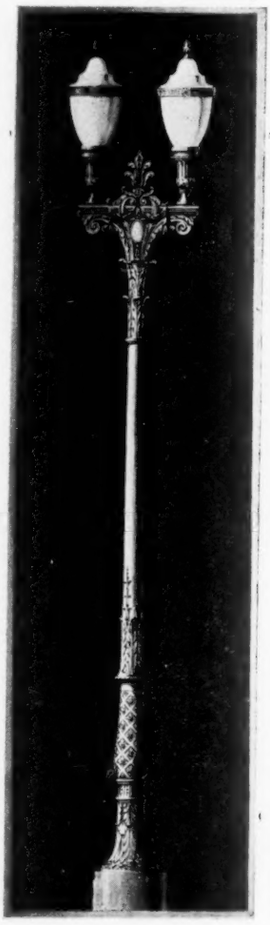
New Jersey Needs Adequate Highway Commission

Edward Edwards, Gov. of New Jersey, in his recent inaugural address, urged the legislator to abolish the present board of eight unsalaried highway commissioners and appoint a board of three adequately salaried men to be in constant session to direct the proper expenditure of nearly $10,000,000 a year that is the present program in this state. The interlocking business of counties and the relations of federal state and county appropriations should be promptly attended to, and it is believed that such a change in highway organization will be welcomed by existing boards now having concurrent powers.

Saratoga's Variable Lighting System

Current diverted at will from pairs of large to pairs of small lamps on same poles by short circuiting at power house.

Saratoga, N. Y., is to have a most distinctive and unique system of street and park illumination. This village of 15,000 population has peculiar conditions to meet. One month of the year it is the scene of a lively program of horse racing, three months it is an active summer resort and the other eight months it is just an ordinary village. As a result four months Saratoga has need for a brilliant lighting system but the other eight months merely an adequate and economical system is desired. W. D'A. Ryan, director of the General Electric Company illuminating engineering laboratory, was asked to survey the situation and make recommendations.



SPECIAL LAMP POST FOR TWO PAIRS OF LAMPS.

Mr. Ryan, who designed the elaborate lighting system for the Panama-Pacific Exposition, the Hudson-Fulton Centennial celebration, Niagara Falls and many of the principal cities of the country, recommended a system which will provide a Great White Way whenever it is wanted and an adequate and economical supply of lighting at other times. Saratoga immediately accepted the plan and installation will be started this spring.

One set of ornamental poles with but one circuit will be erected. On Broadway, Saratoga's principal street, a double globe fixture will be used. On the outskirts and in the parks the single globe will be used.

In each globe will be two Mazda lamps, one of 250 candle power and the other of 1,000 candle power. In the base of each pole will be a small relay box. By short circuiting the current at the power station, causing but a slight flicker in the illumination, these relay boxes will change the current from the big to the little lamp, or vice versa, as many times as occasion demands. So, during the summer season, the main street will be a Great White Way the early hours of the evening when the big lamps are used. At midnight, when need for these bright lights has passed, the current is short circuited and is shifted to the small lamps, adequate for all requirements from this hour until morning. And by the same arrangement the small lights may be used the entire night during the quiet eight months.

The standards will be located opposite each other on the streets at approximately 135 feet spacing. The height of the center of light source will be 20 feet. This Duo-flux system has never before been attempted and the outcome will be watched with interest by other cities which face a similar problem.

English Cannel Tunnel

The construction of the long proposed tunnel under the English Channel, from Dover to Calais is discussed in the London Times Sept. Engineering Supplement by J. V. Davies, New York, of the firm of Jacob & Davies, prominent tunnel engineers, employed on the construction of the Hudson Tubes, the Pennsylvania Railroad tunnels, the Consolidated Gas Co. tunnels and some of the Rapid Transit tunnels New York City. Mr. Davies estimates that the tunnel about 29 miles long between portals, could be driven through the chalk stratum under water 180 feet deep and at the section 24 miles long between the shore shafts could be excavated at the rate of 1,275 feet per month, thus requiring about 4 years for the headings to meet.

This estimates the attainment of a speed about 20 per cent greater than the best record yet made, namely, 932 feet in the Rogers Pass tunnel of the Canadian Pacific Railroad that was driven in 1913–1916 through soft slate shale.

The character of the rock which can probably be advantageously excavated by machinery, the moderate temperature that will be encountered, the location convenient to good labor markets and improvements in machinery and appliances are considered to justify this estimate which corresponds with a cost of about $150,000,000, nearly twice as much as was estimated before the war.

Timbering Deep Rock Shaft from Suspended Platform

A 14 x 5½-foot rock shaft in the Tintic District, Utah, was sunk 517 feet in 62 working days by the aid of a horizontal timber platform covering the entire area of the shaft and suspended by differential chain hoists from the timbering which was itself suspended, course by course, as the work proceeded.

This platform served as a scaffold for the timbermen to work on and prevented any objects dropping on the miners below. It was faced on the lower side with thin steel plates and was secured to the lower timbers of the bracings by wedged cramps or dogs. The shaft was lagged with 2-inch planks braced against longitudinal and transverse horizontal timbers that were separated by vertical spacers. The rock was drilled and blasted every 12 hours, the four men of each gang working alternately as miners or muckers, as required.

During the week ending February 7 snow in the street of Harrisburg, Pa., was removed by a force including 345 foremen, 2,285 laborers and 18 caretakers so that a total of 2,648 men was employed. The Highway Department had in use 35 automobile trucks on which snow plows were mounted. It also used 243 horse-drawn road machines. The same number of teams and wagons were in use, or a total of 521 vehicles.